

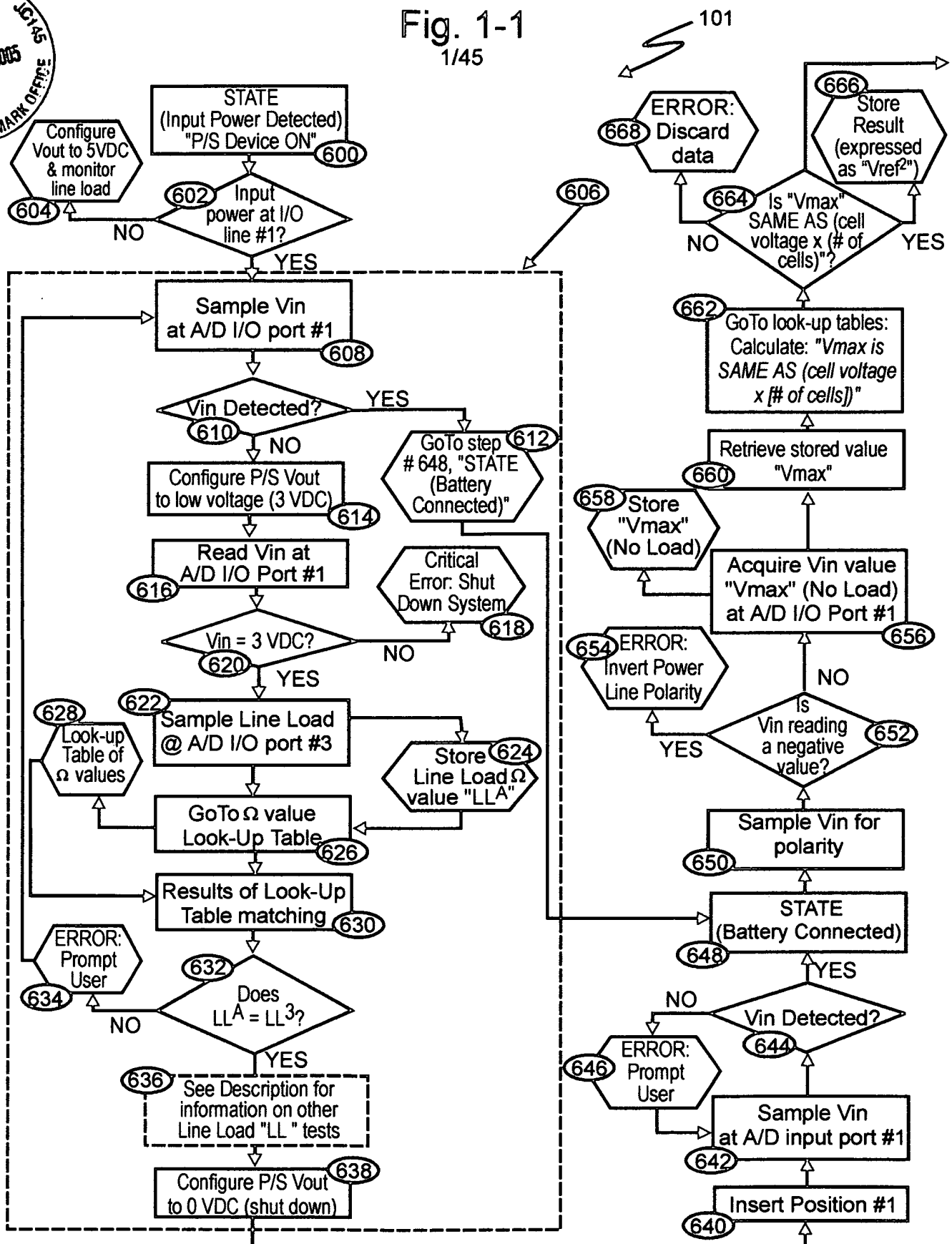
Fig. 1-1  
1/45

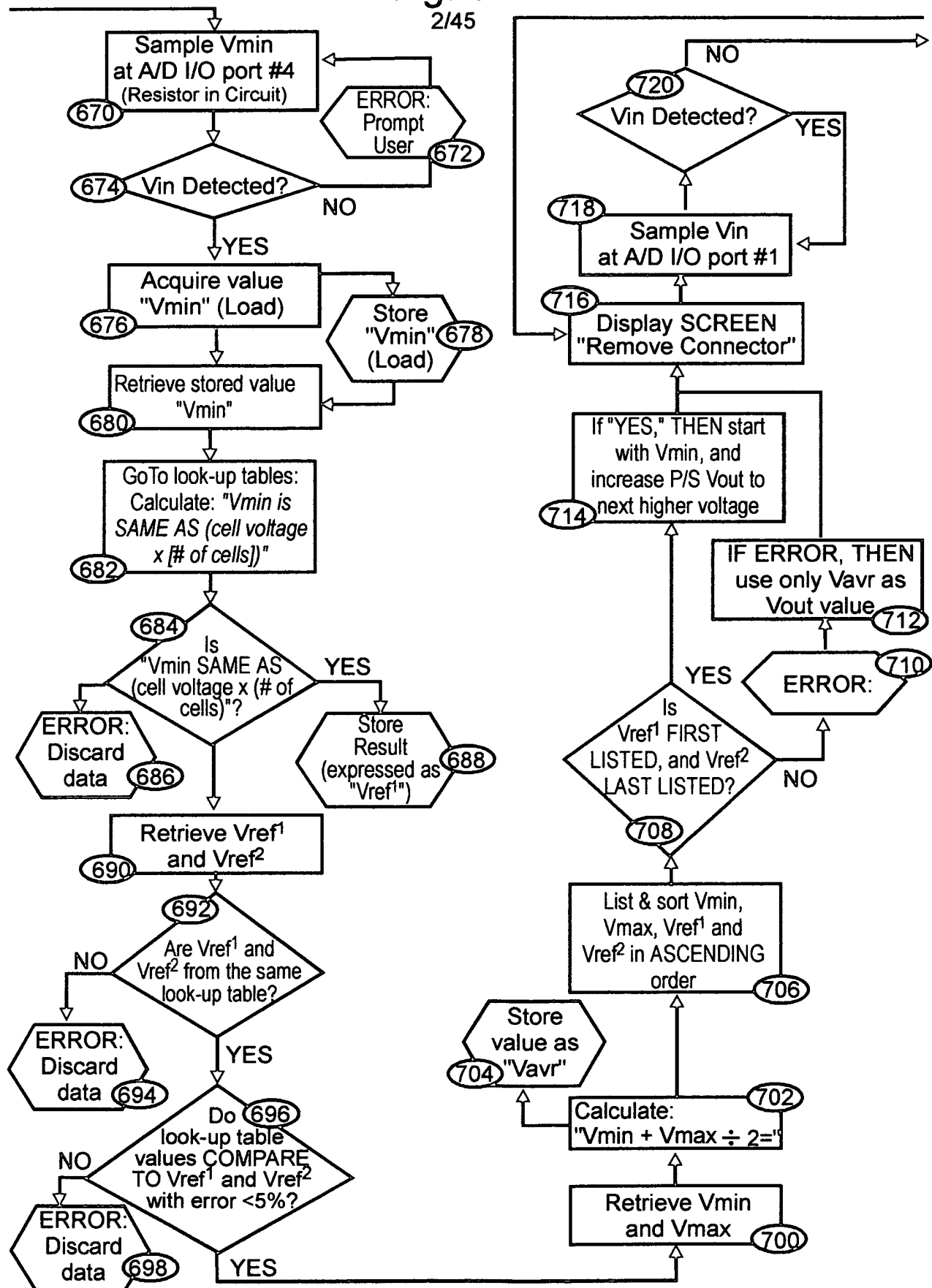
Fig. 1-2  
2/45

Fig. 1-3

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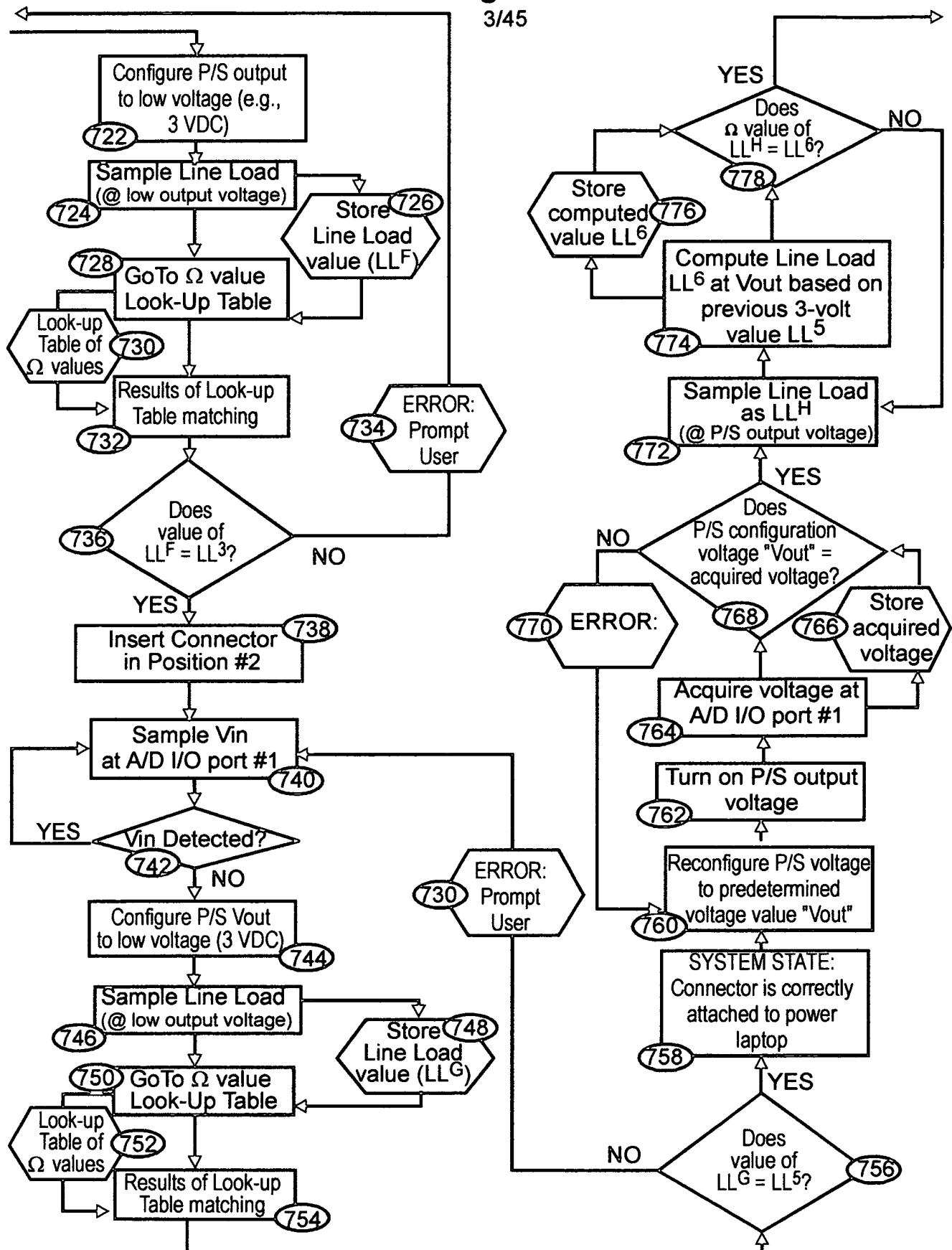


Fig. 1-4

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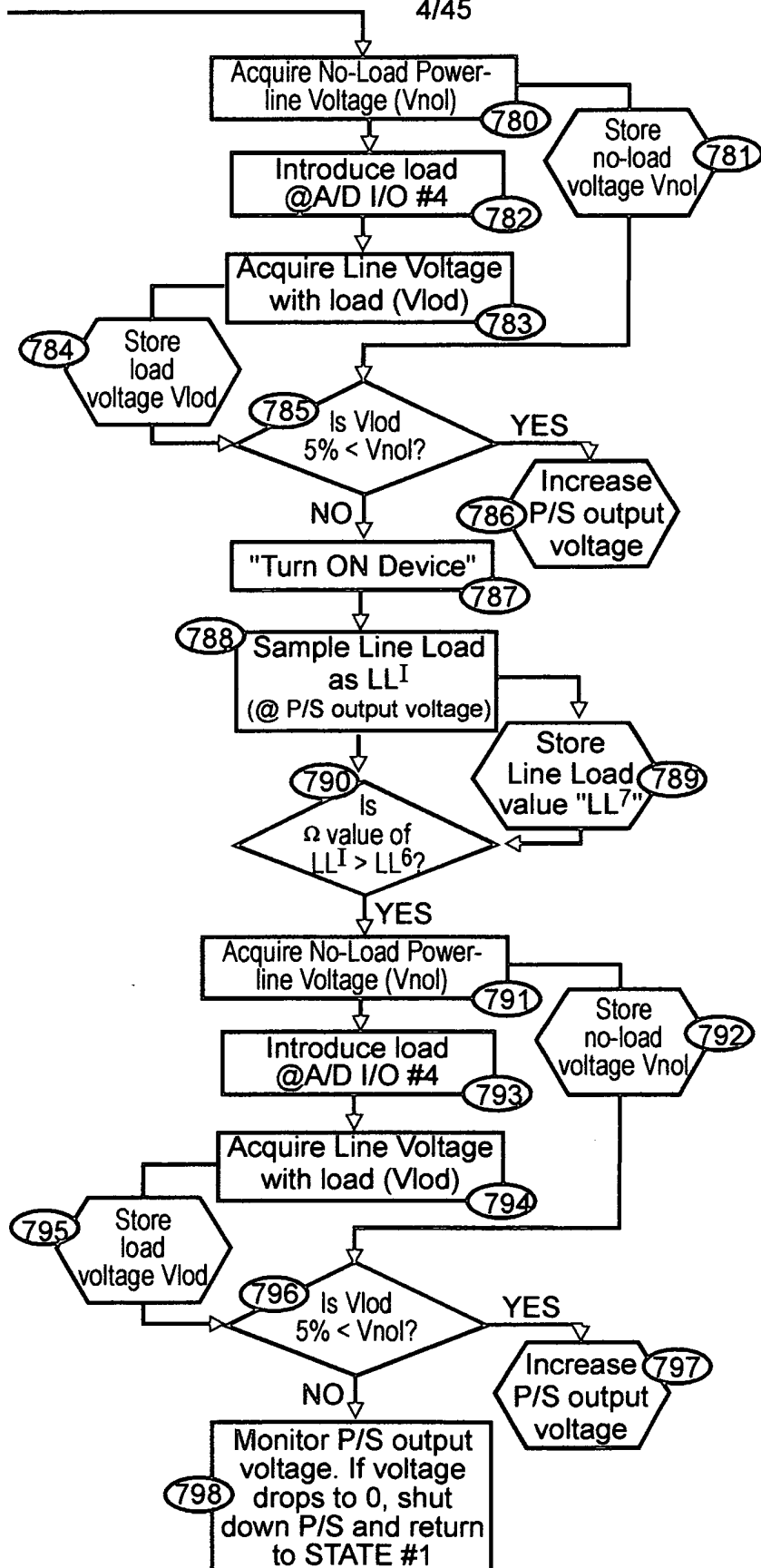


Fig. 1A-1  
5/45

# Software for In-line Coded Device

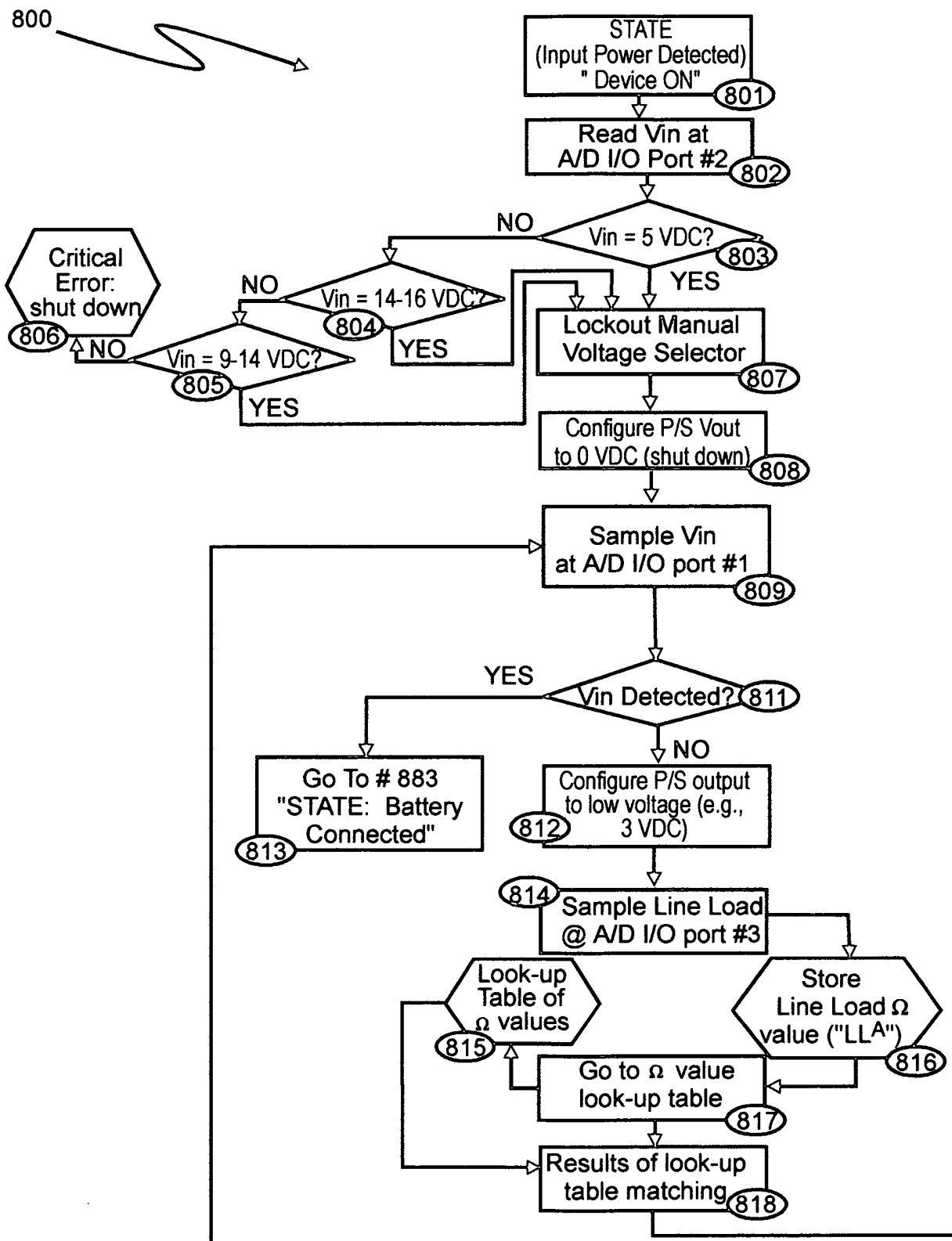


Fig. 1A-2

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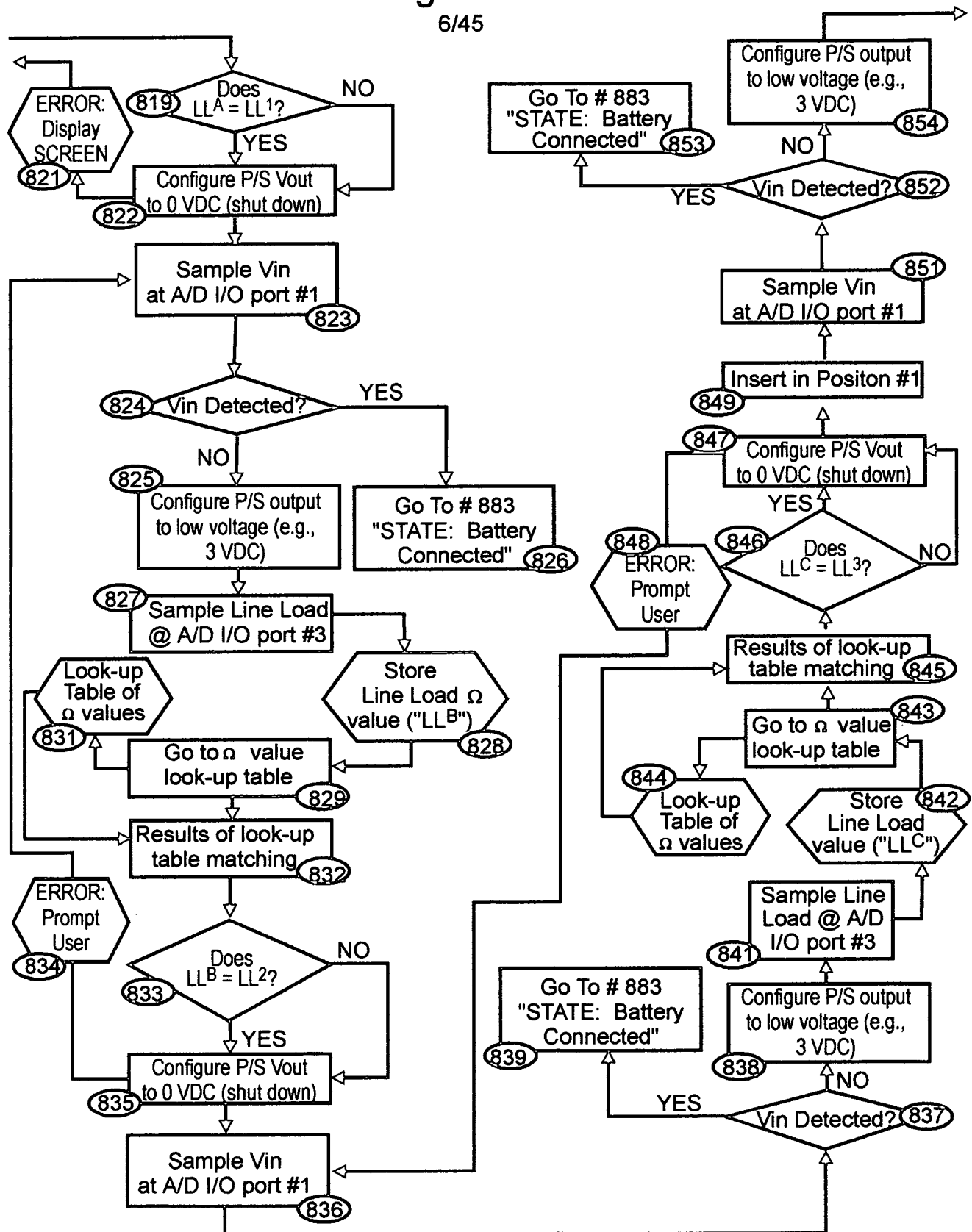


Fig. 1A-3

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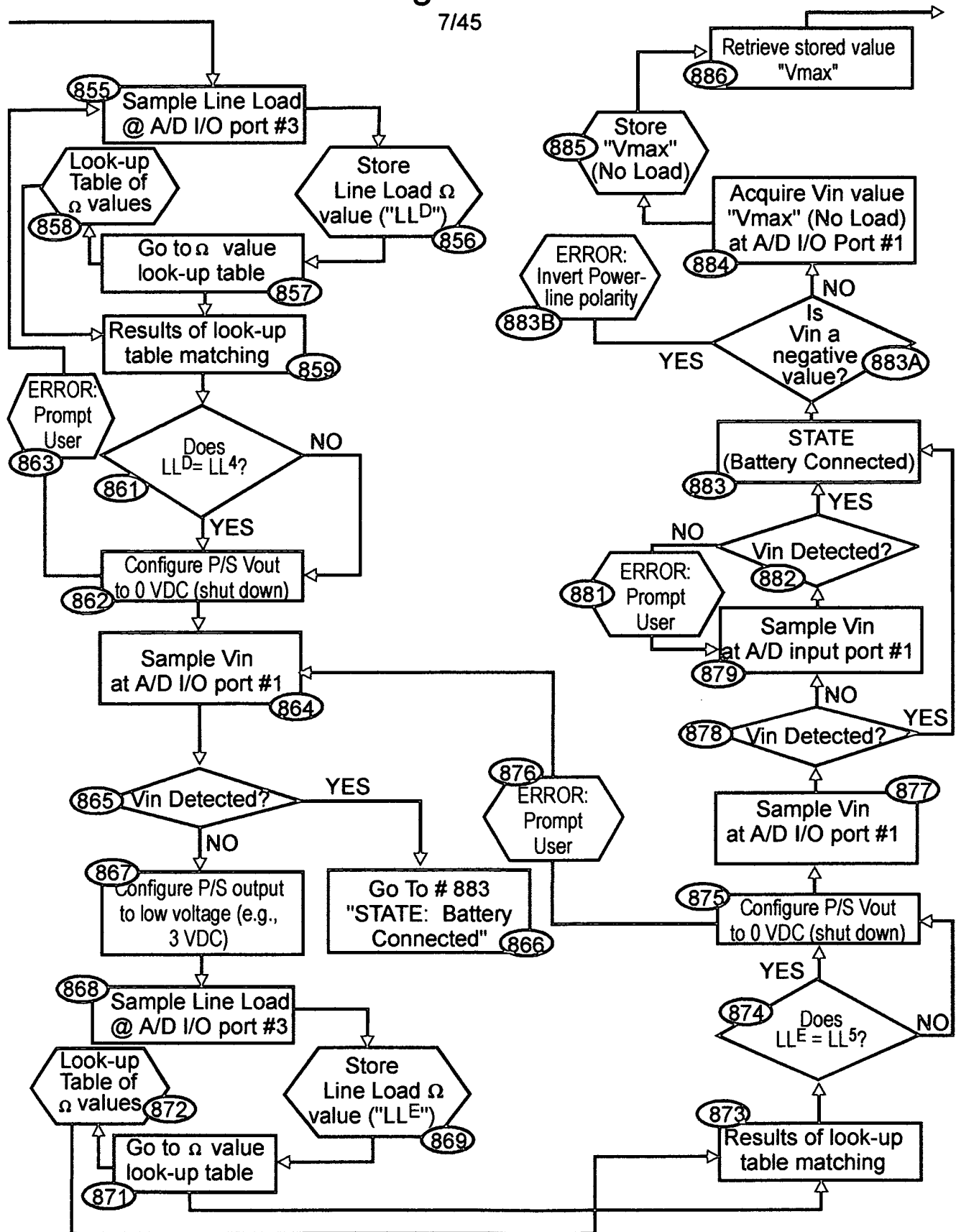


Fig. 1A-4

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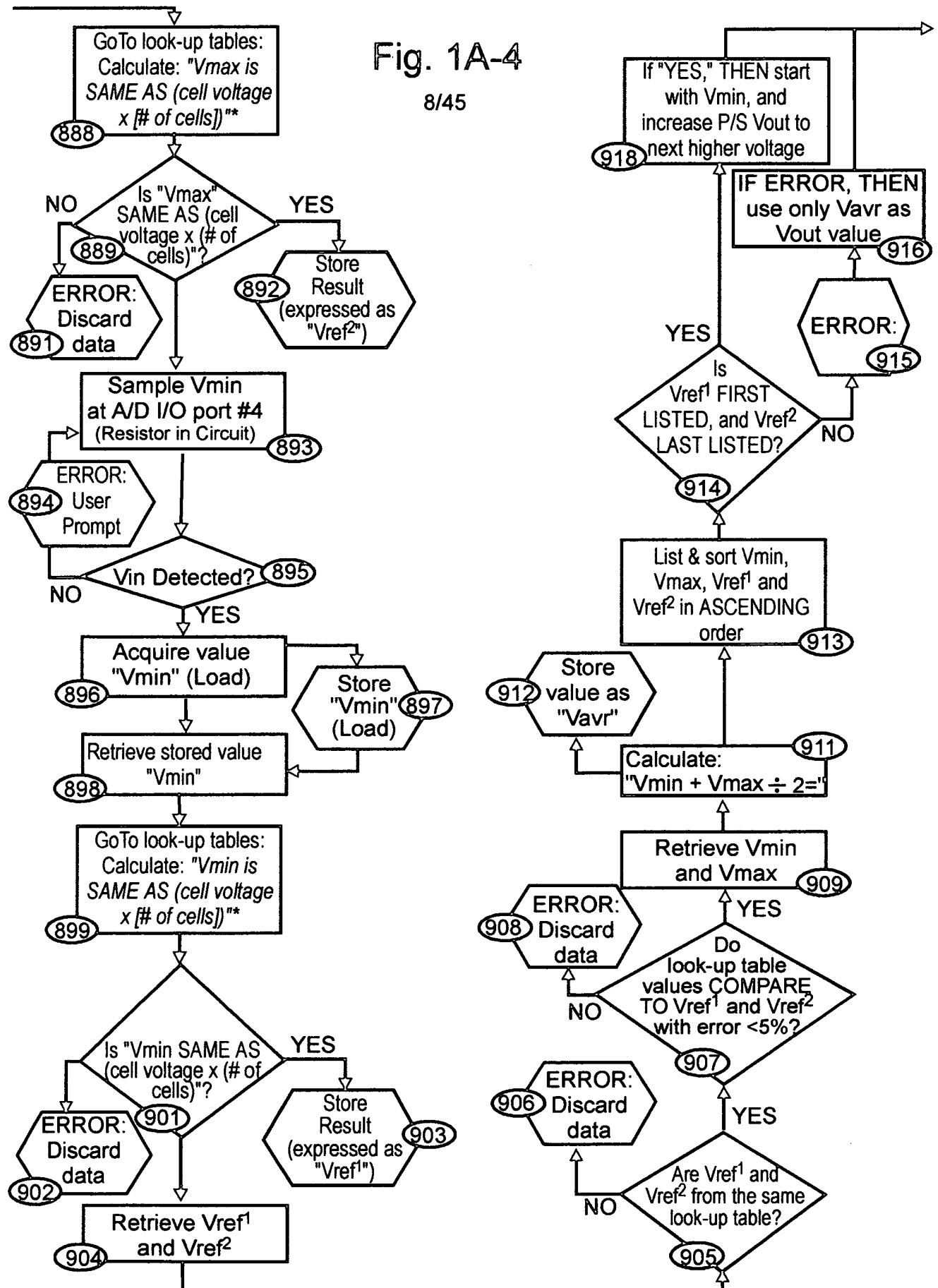




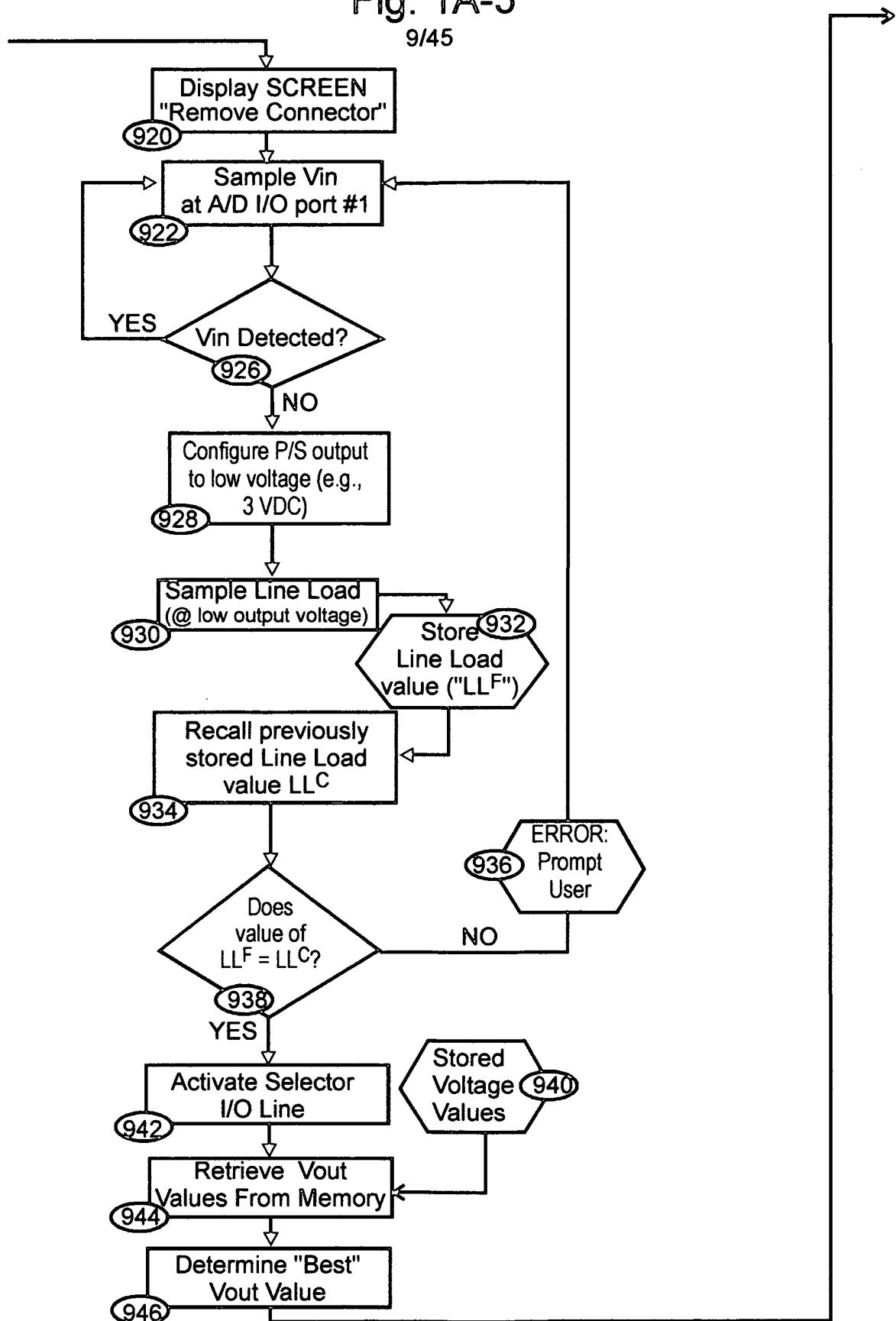
Fig. 1A-5  
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Fig. 1A-6

10/45

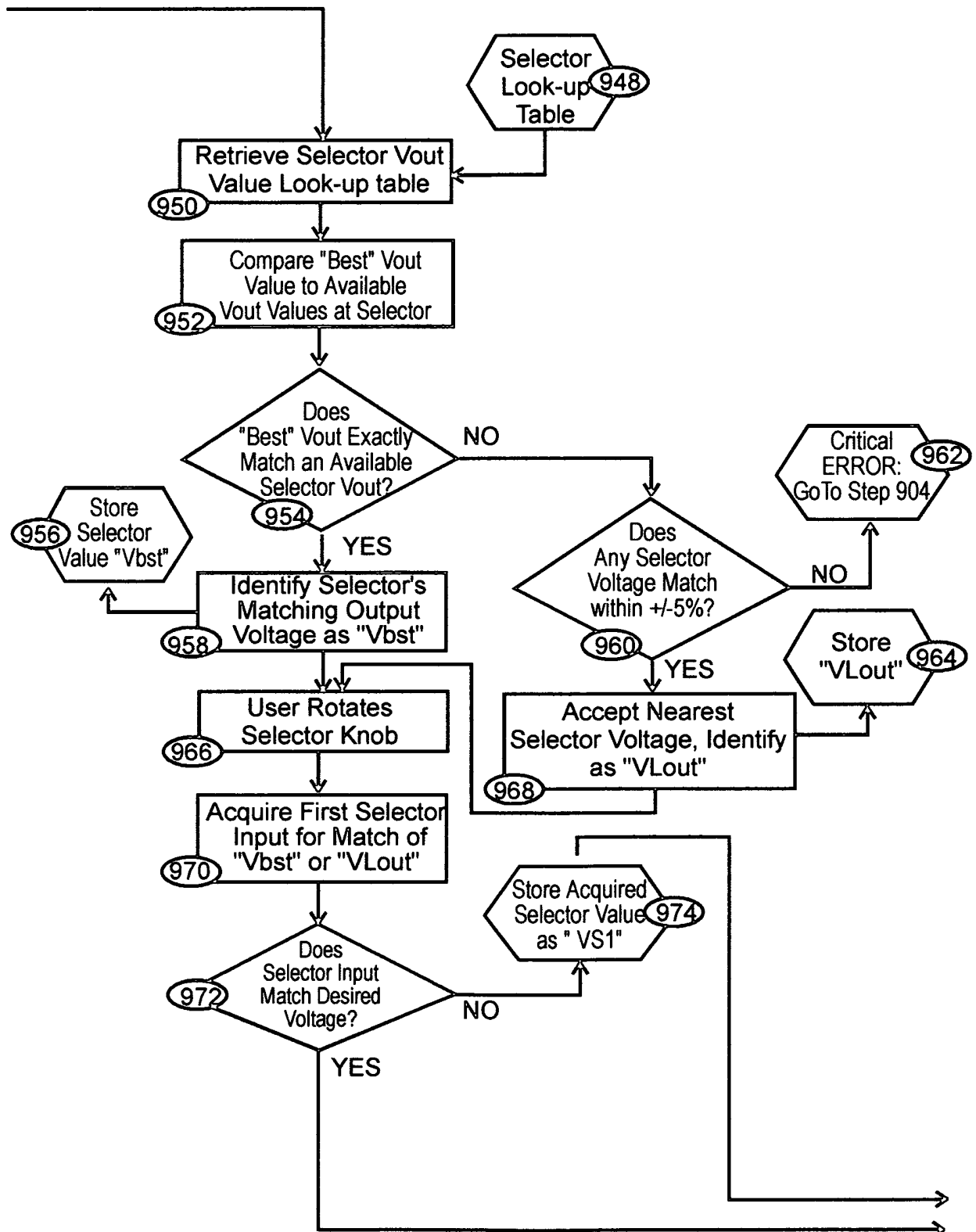


Fig. 1A-7

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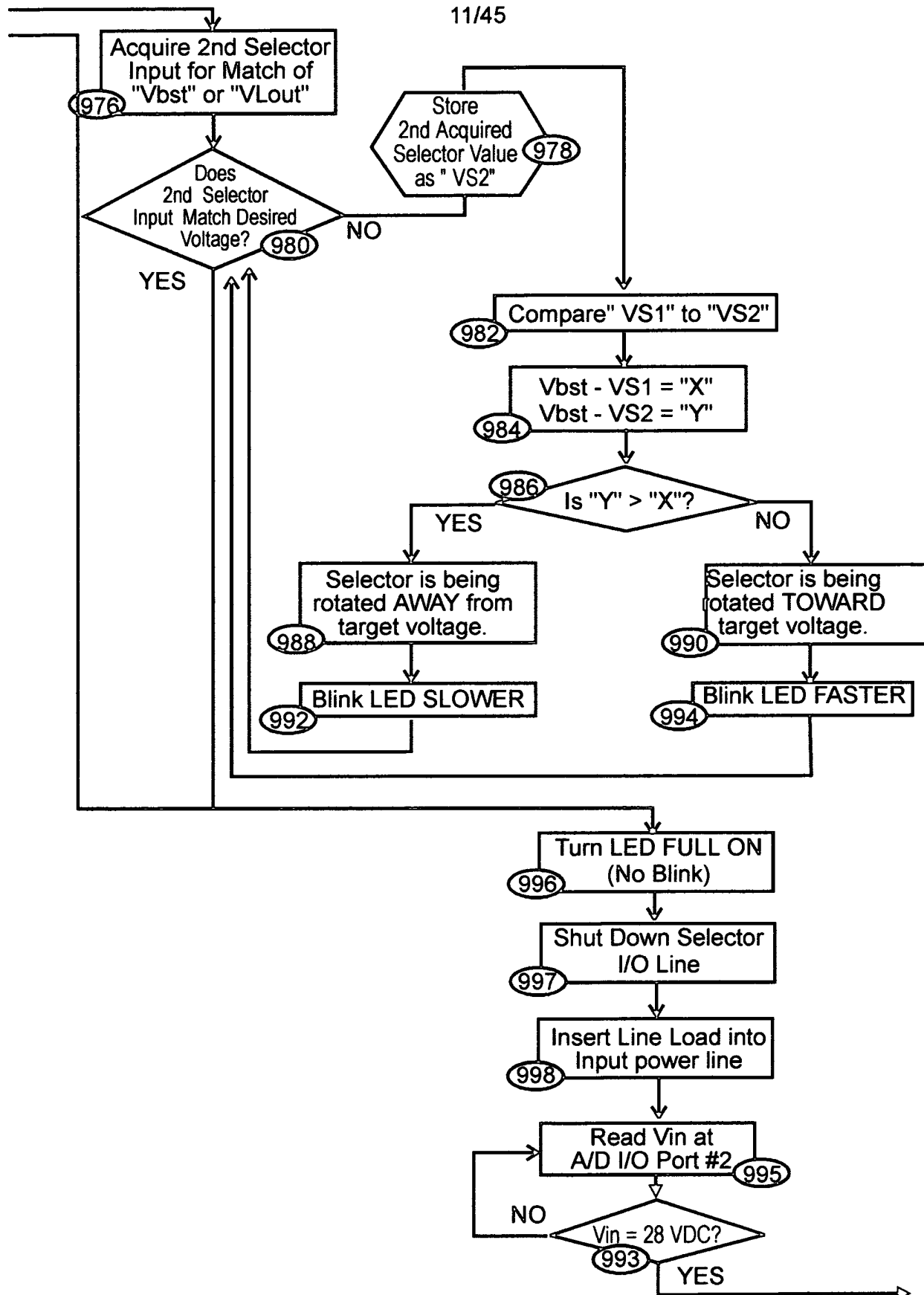


Fig. 1A-8

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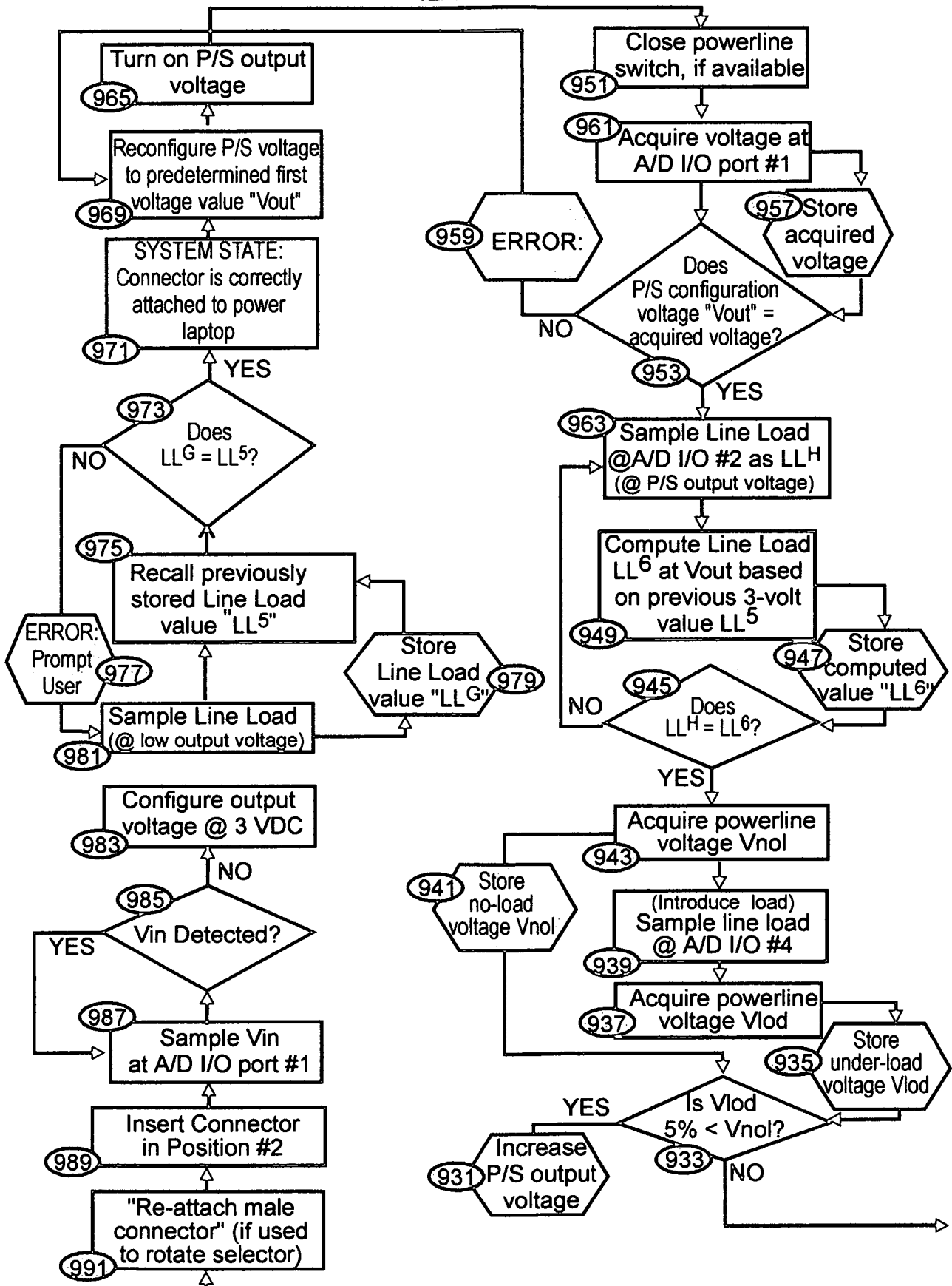
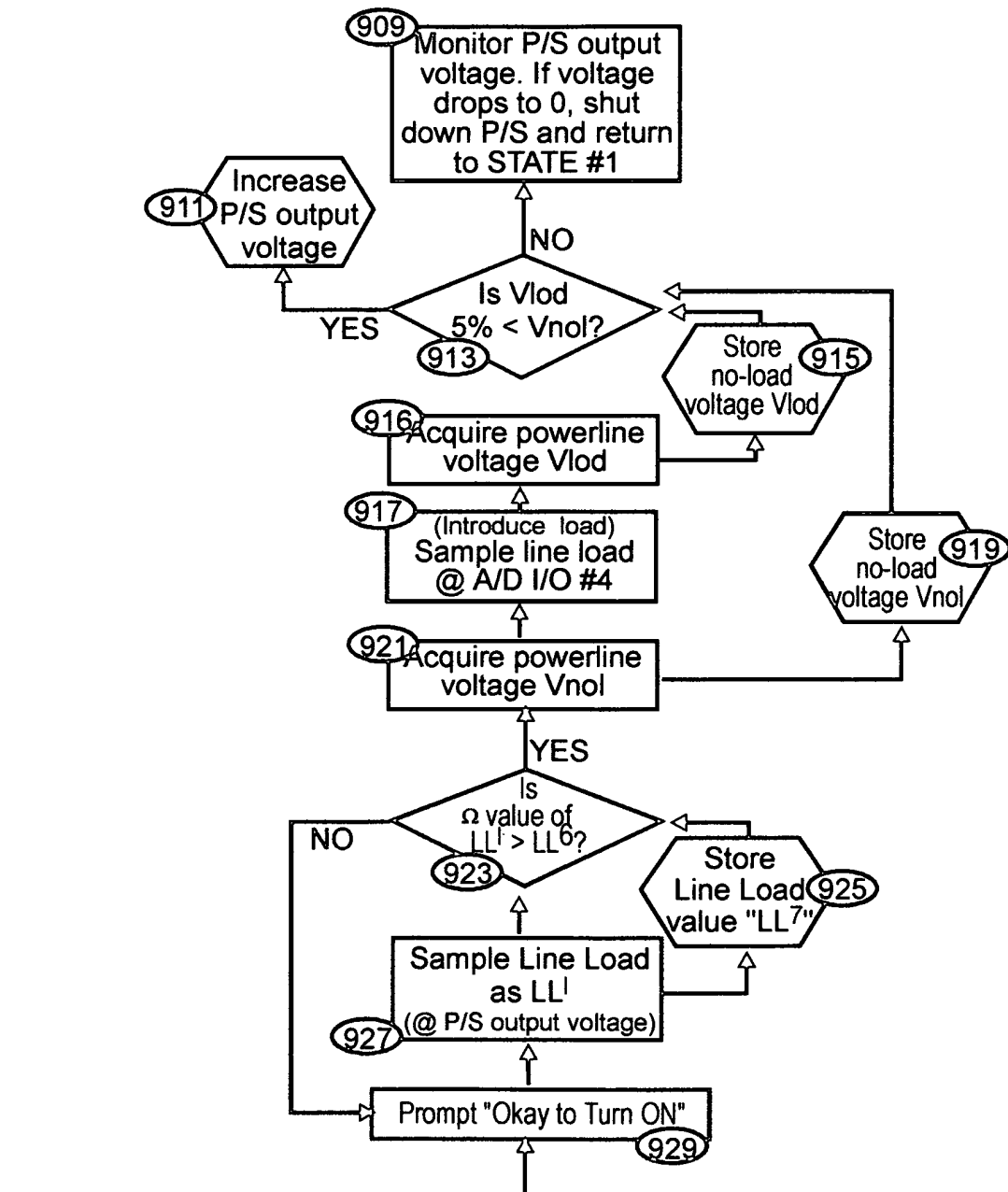


Fig. 1A-9

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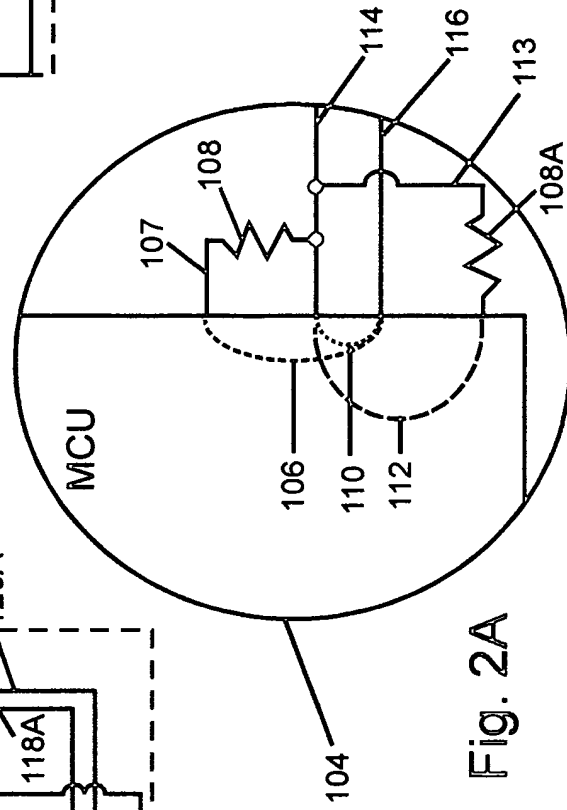
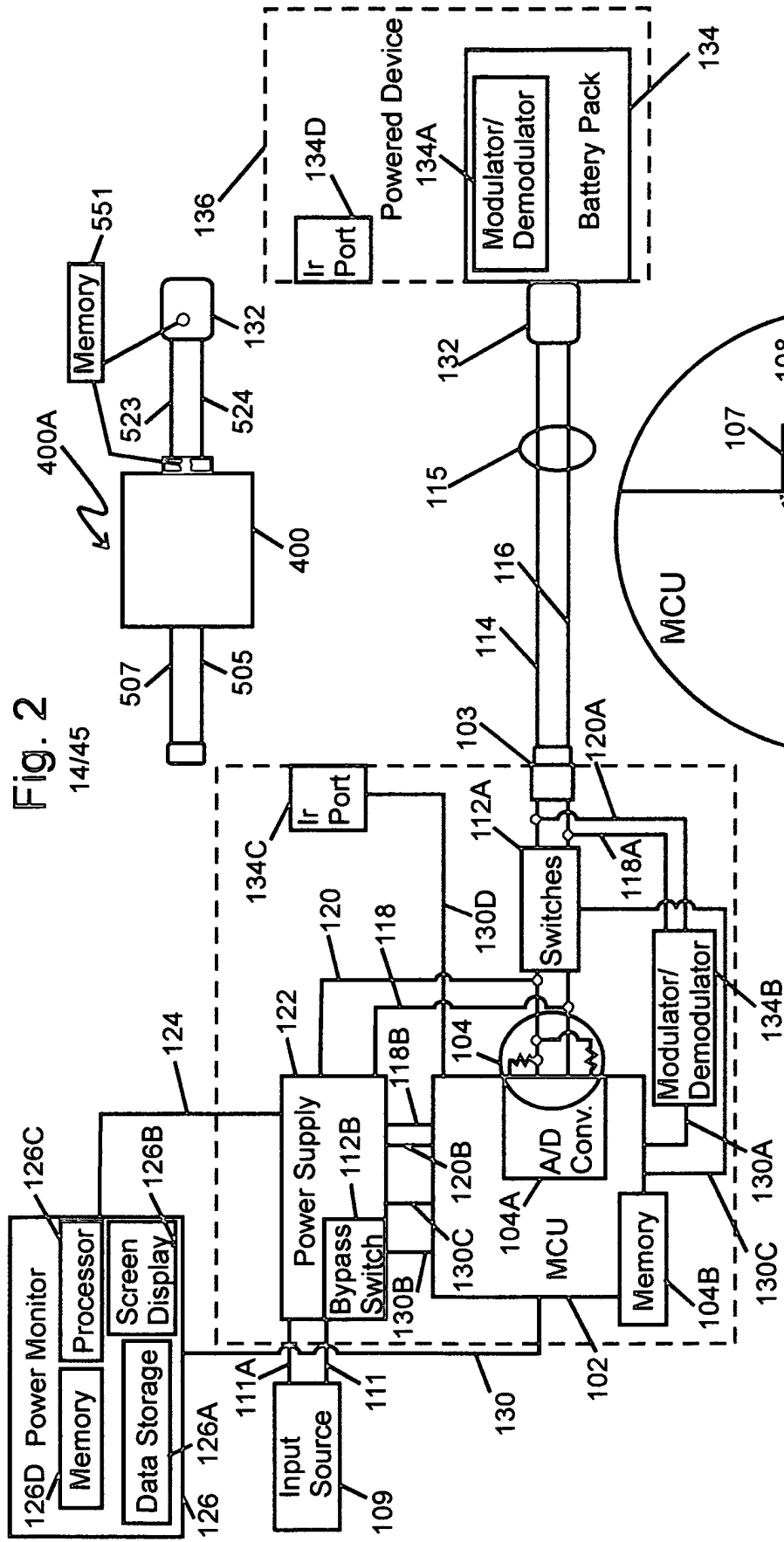
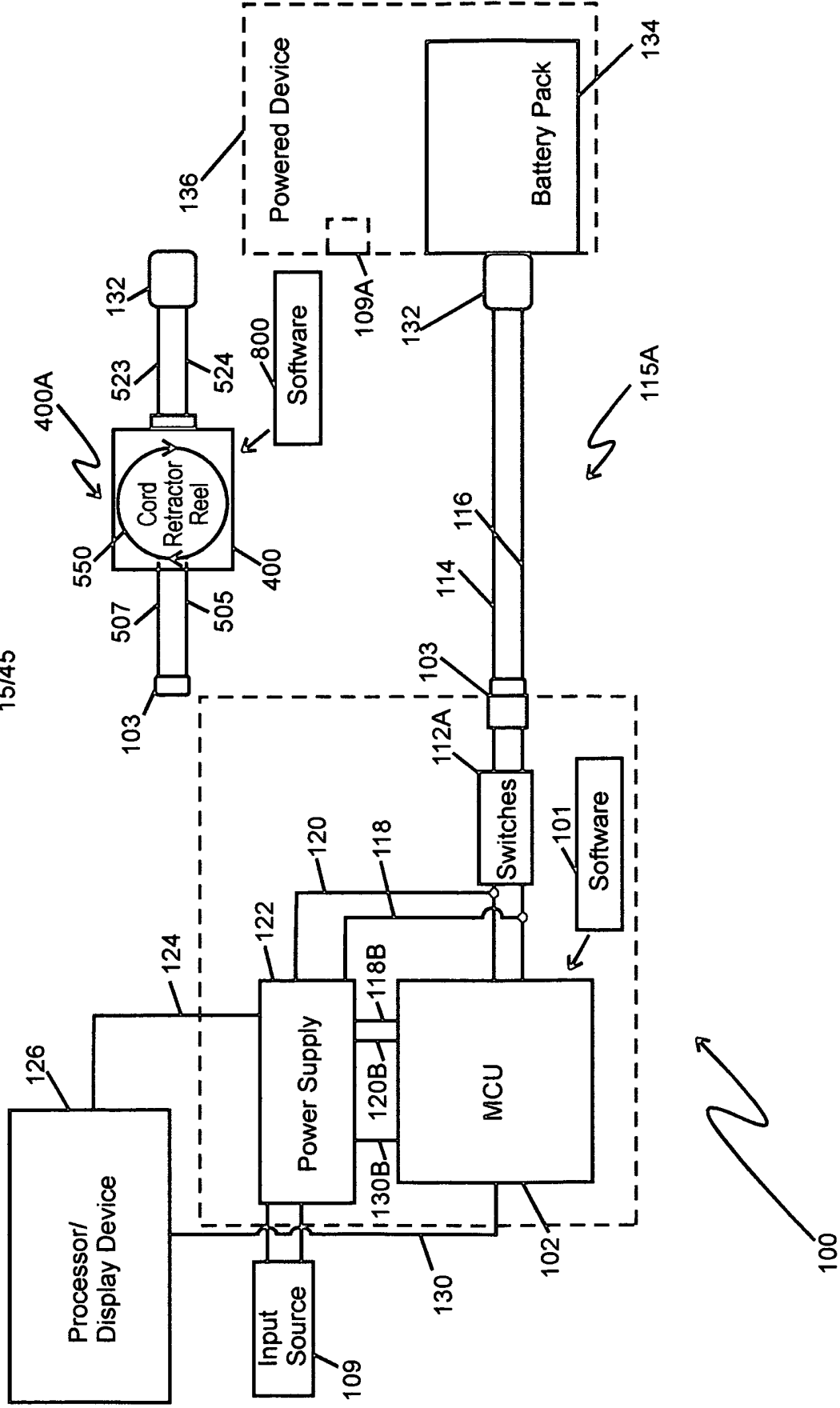
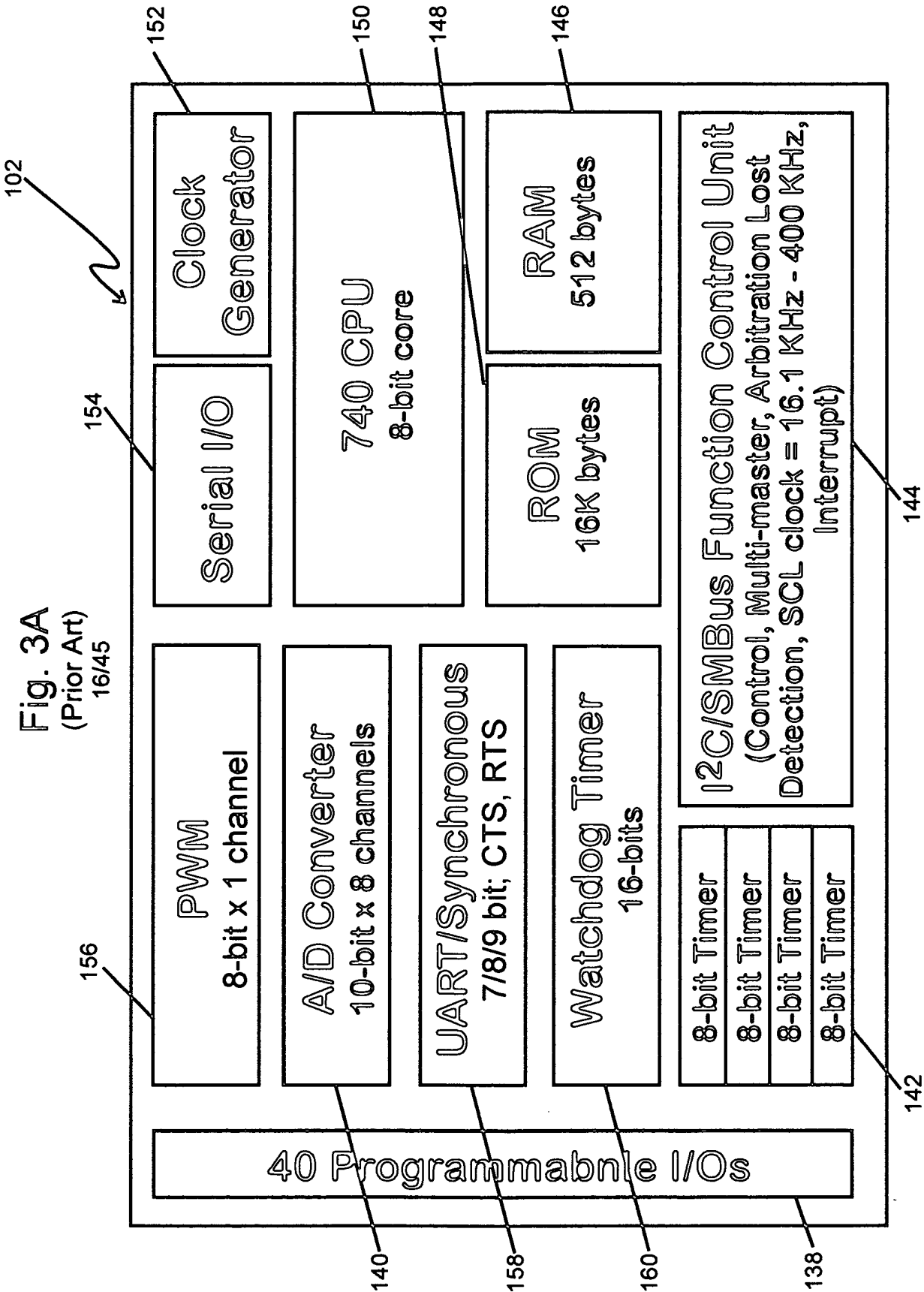


Fig. 2B

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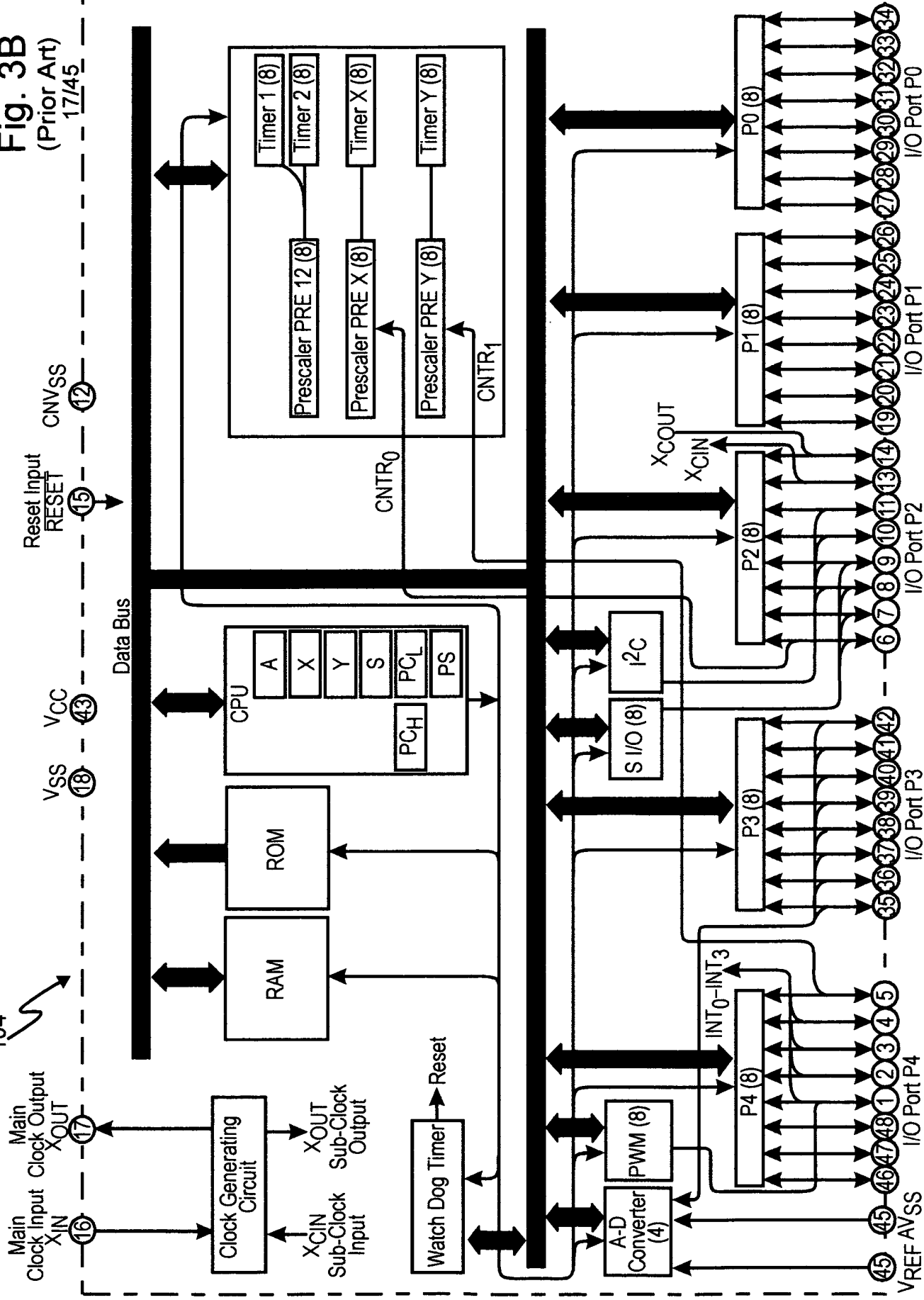






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**Fig. 3B**  
(Prior Art)  
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**Fig. 4-1**  
(Prior Art)  
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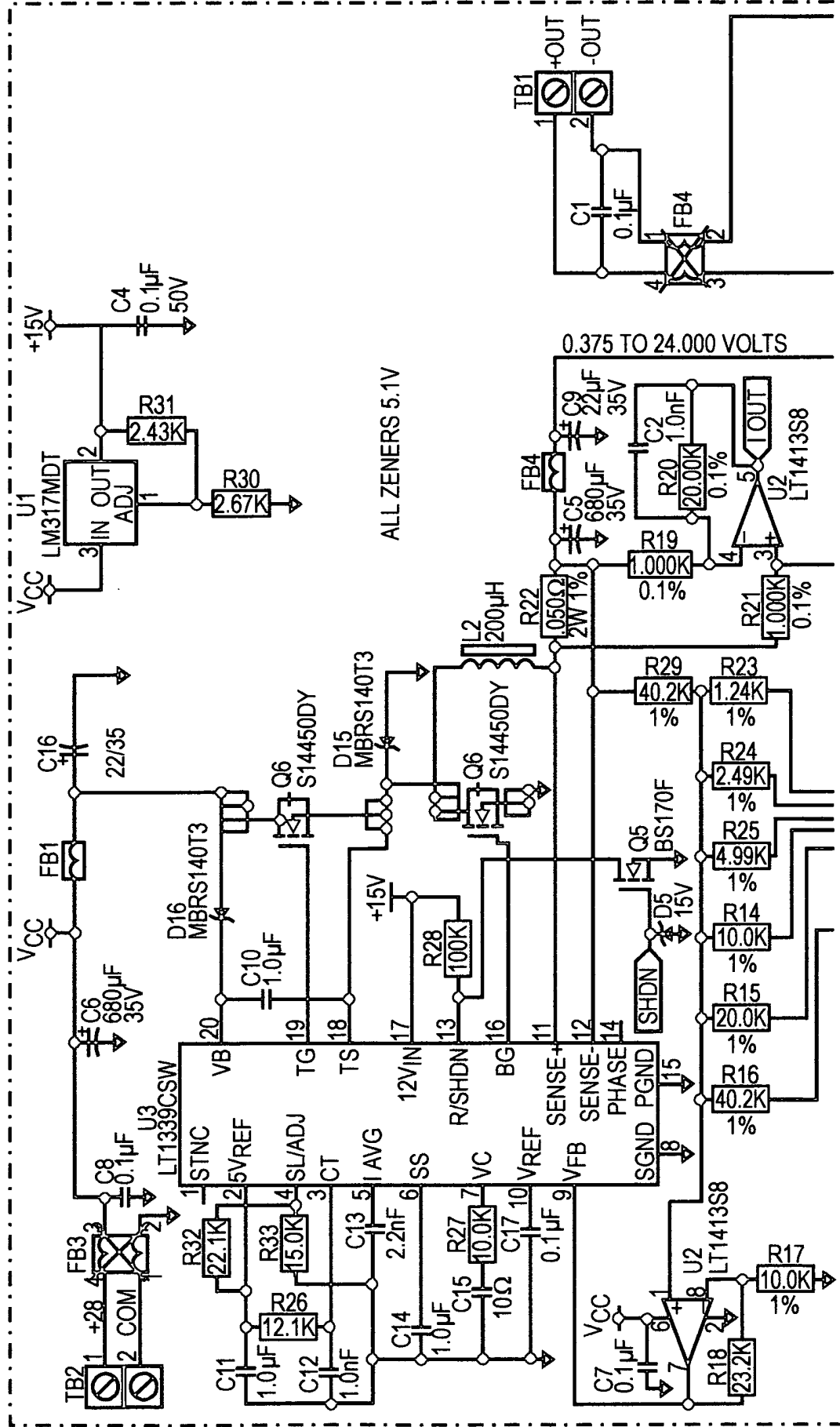
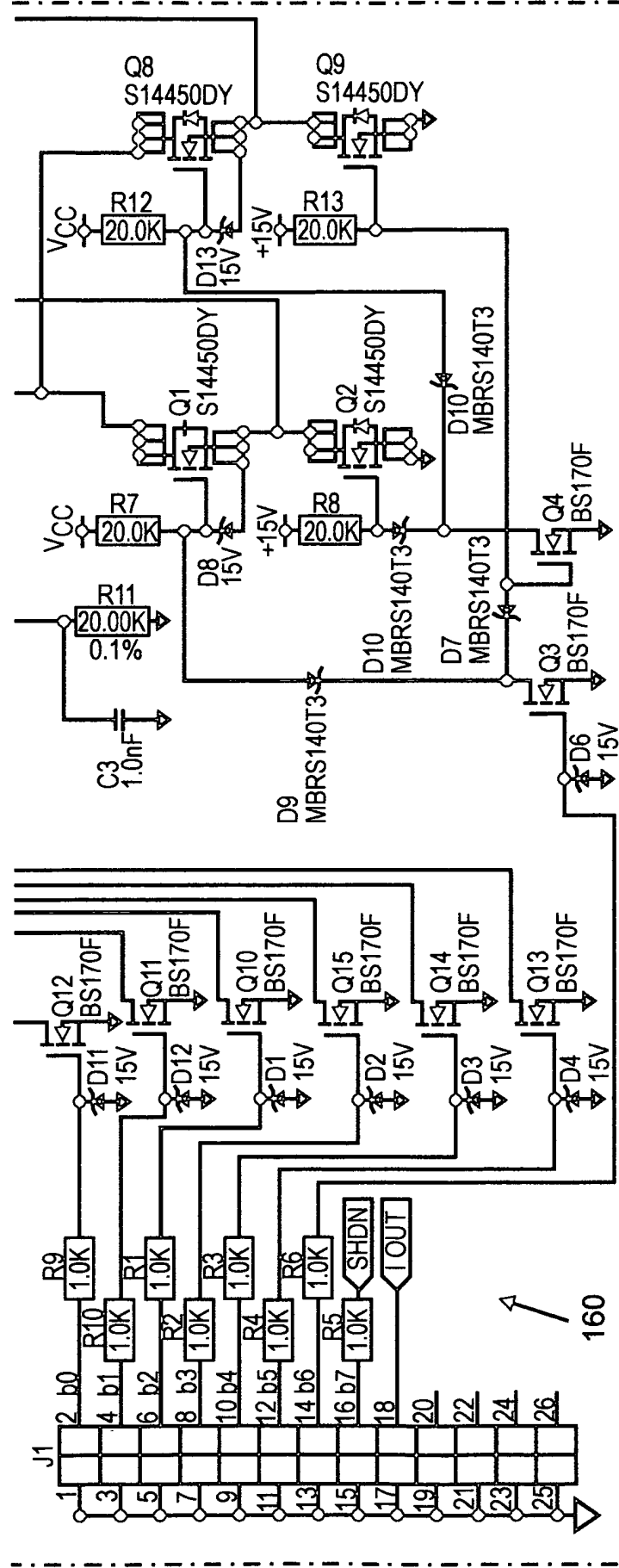
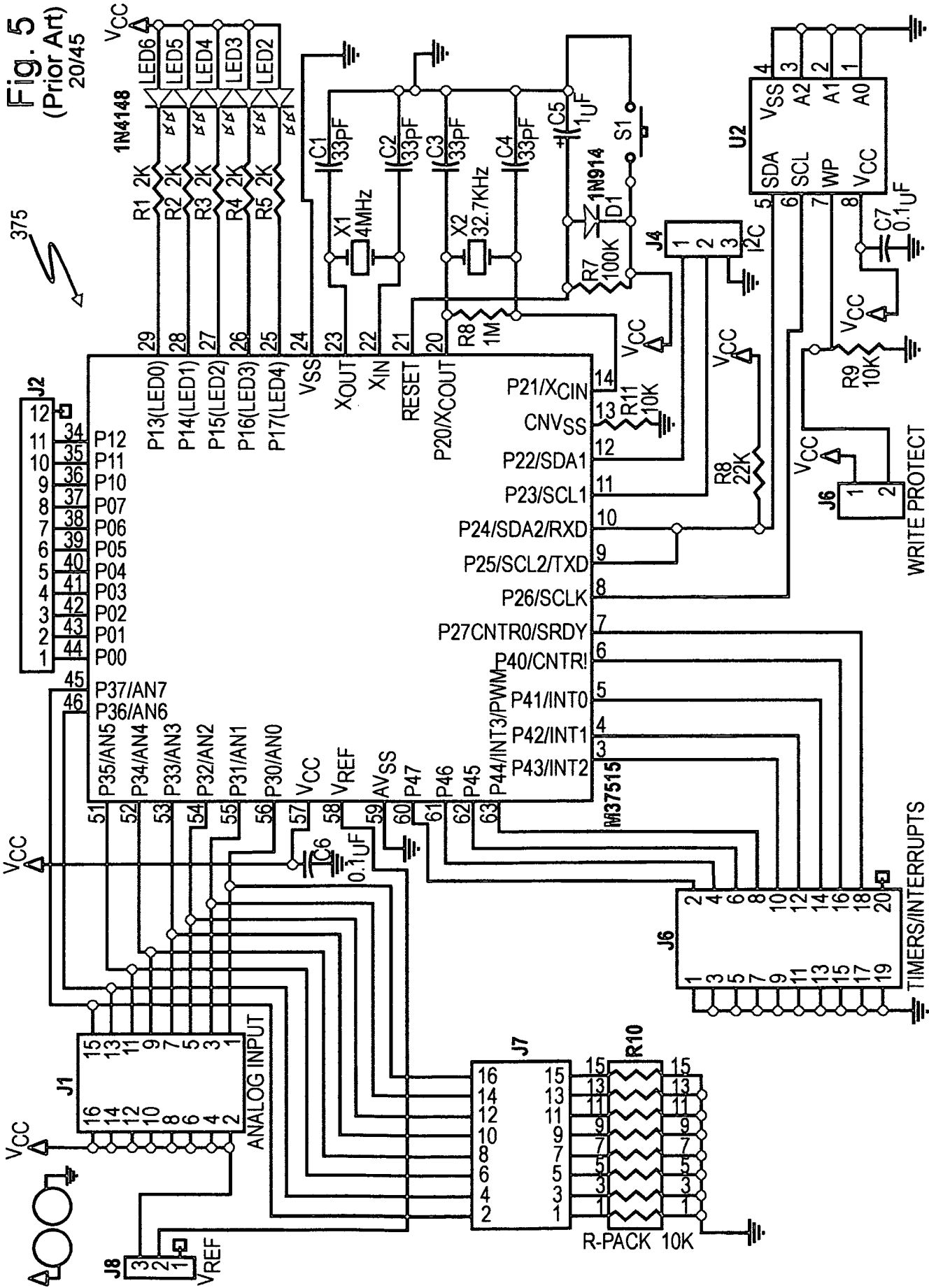


Fig. 4-2  
(Prior Art)  
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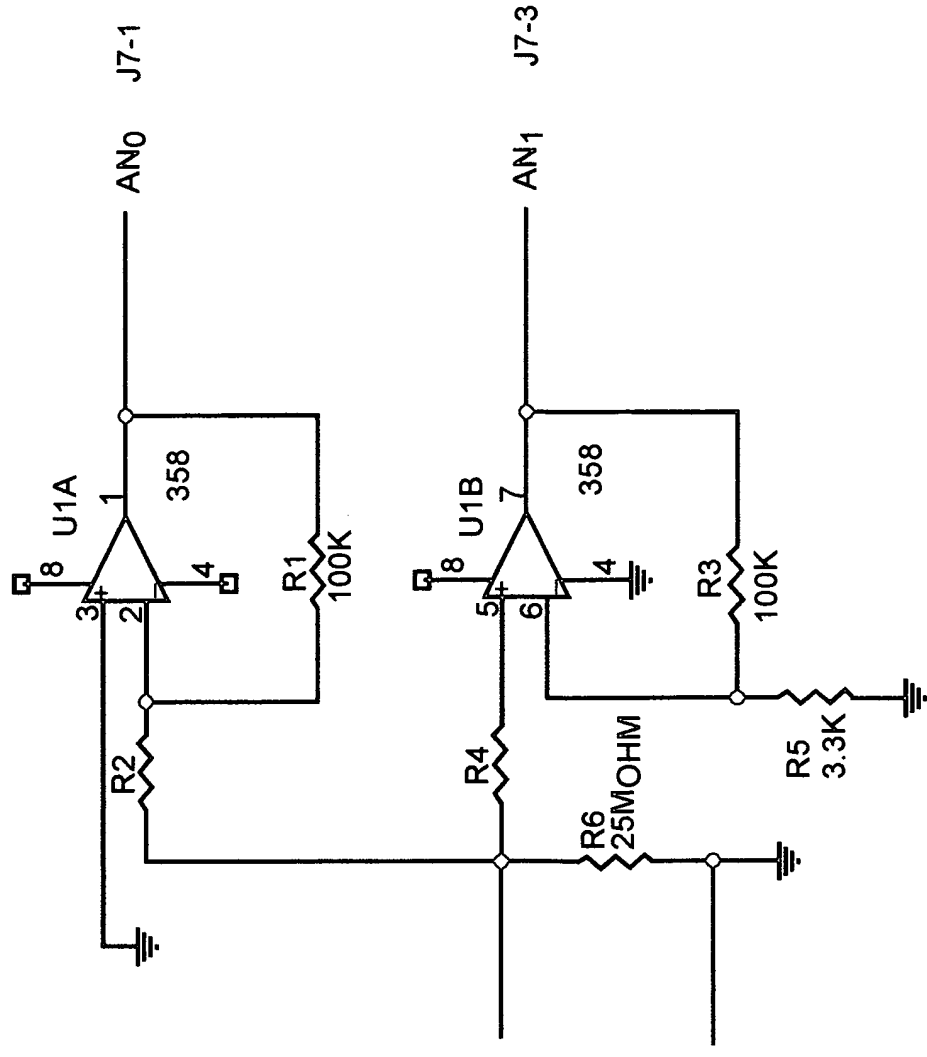
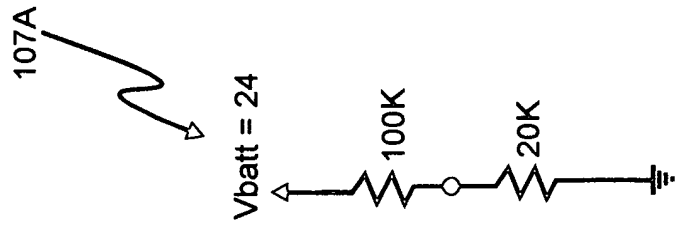


Fig. 5A  
(Prior Art)  
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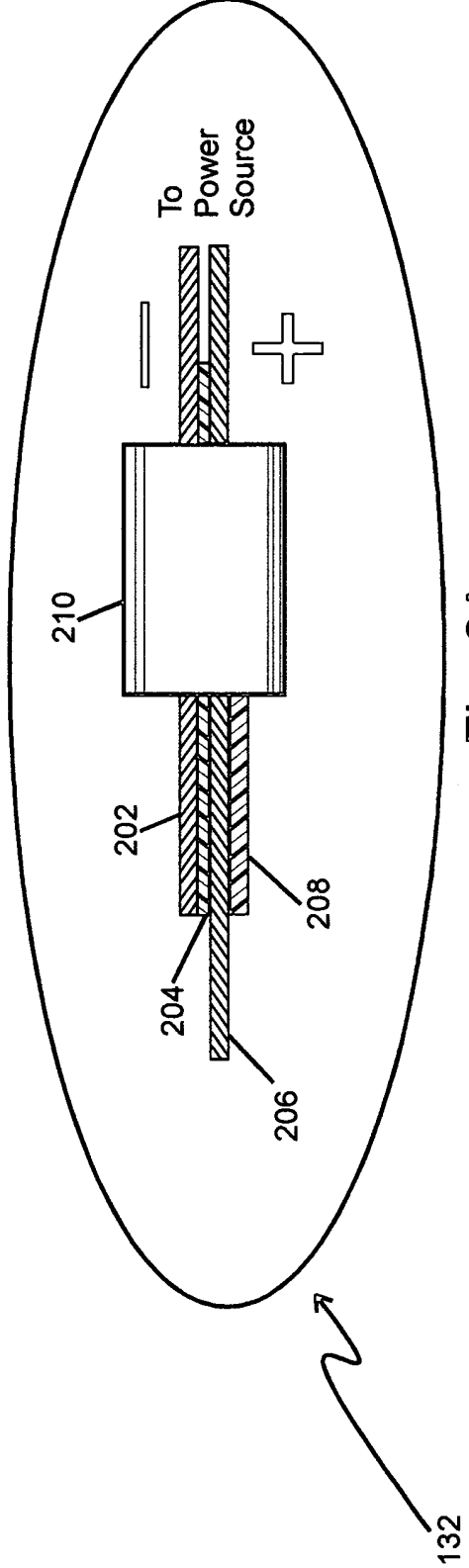
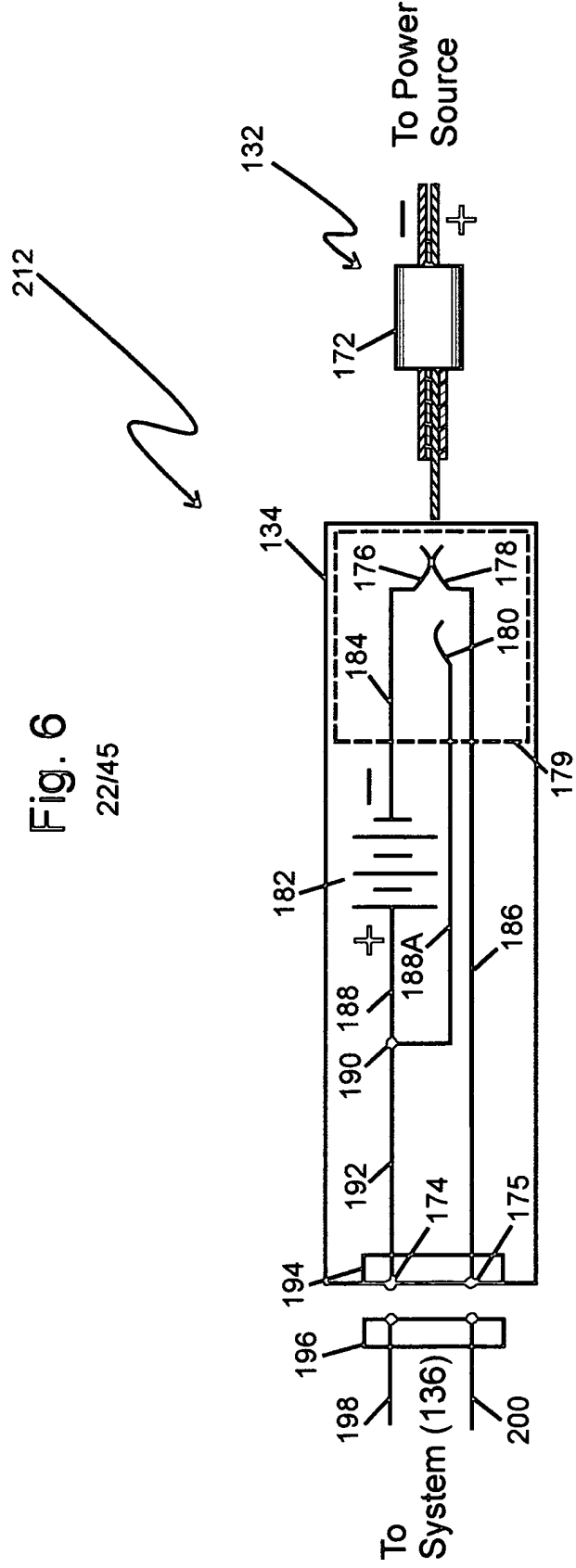


Fig. 6A

Fig. 6B

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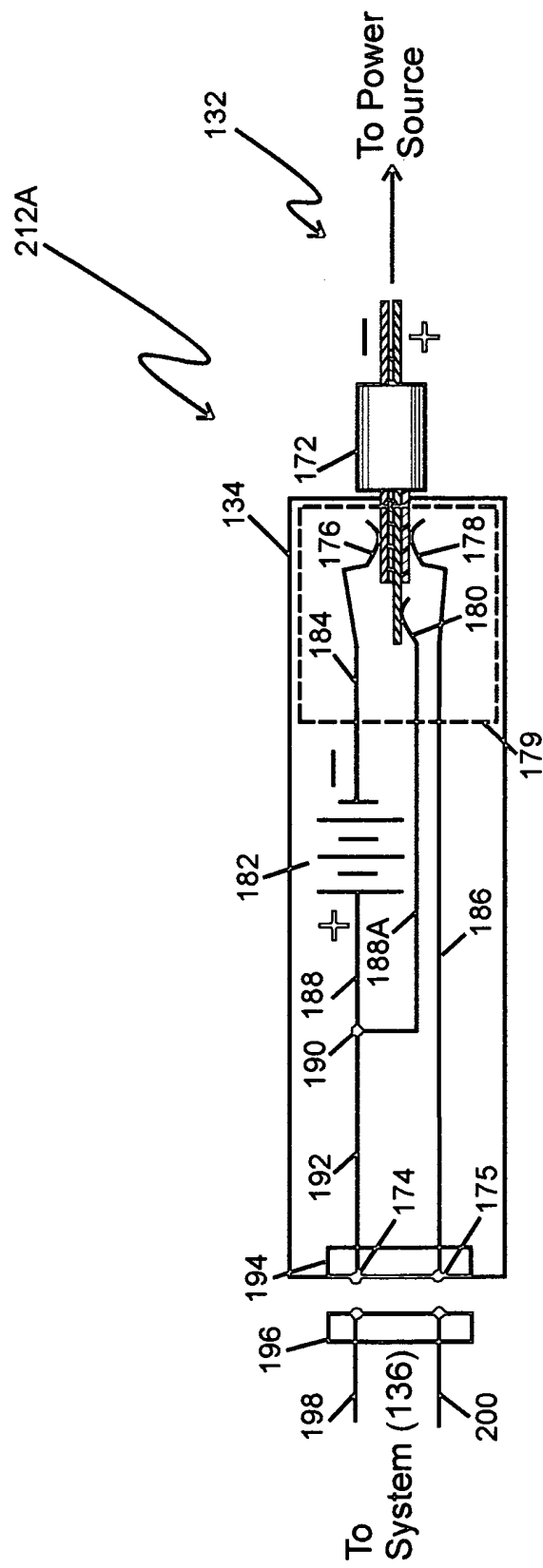


Fig. 6C  
24/45

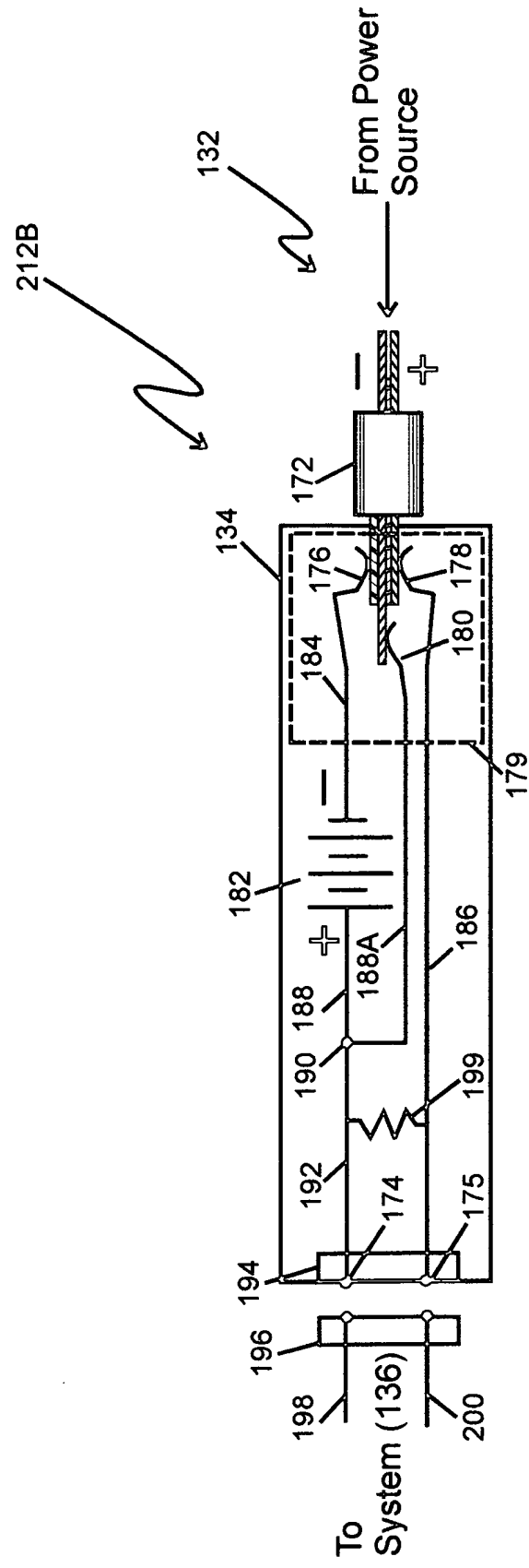




Fig. 6D

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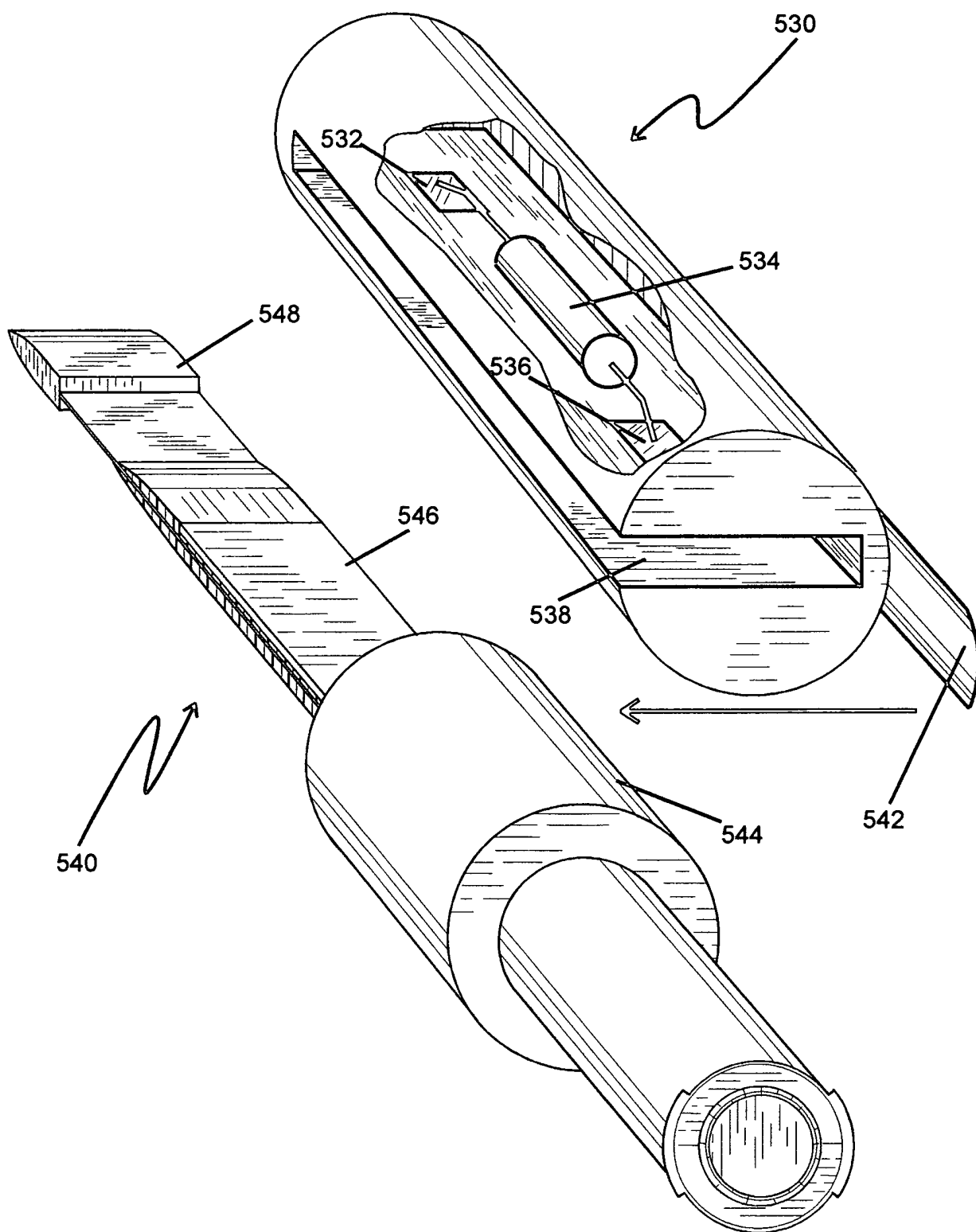
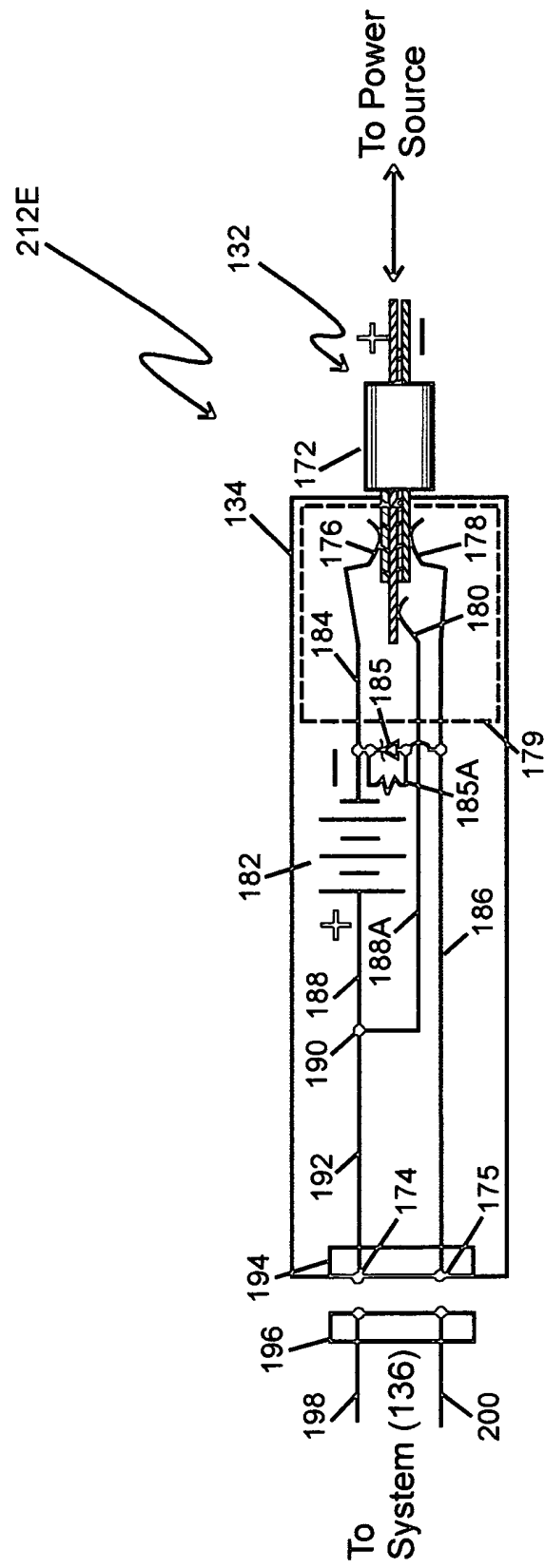


Fig. 6E

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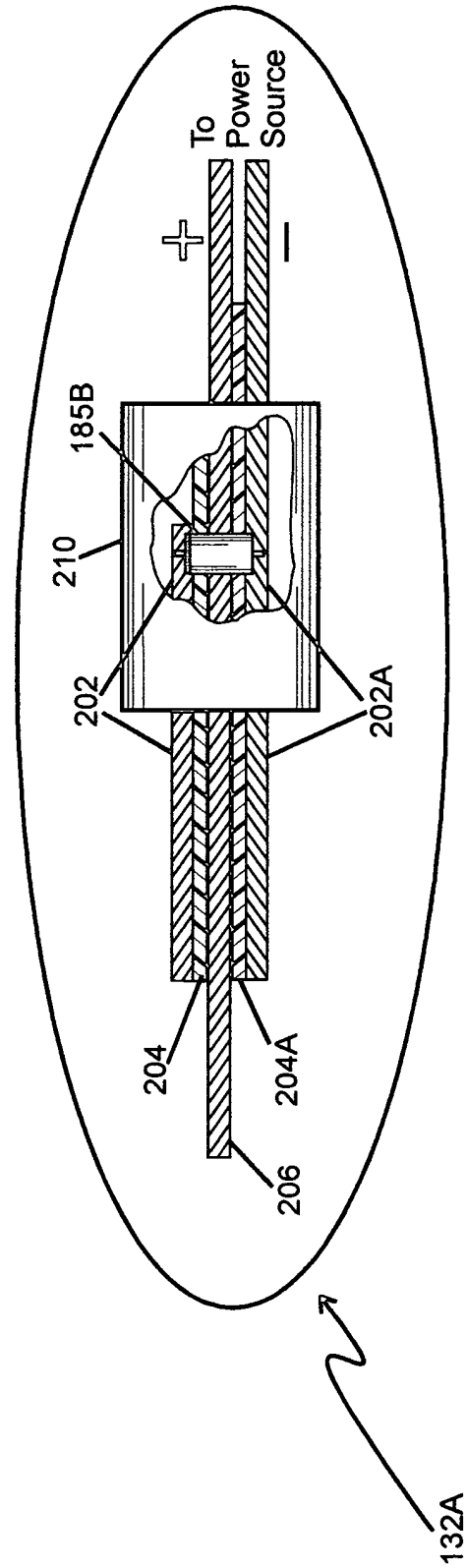
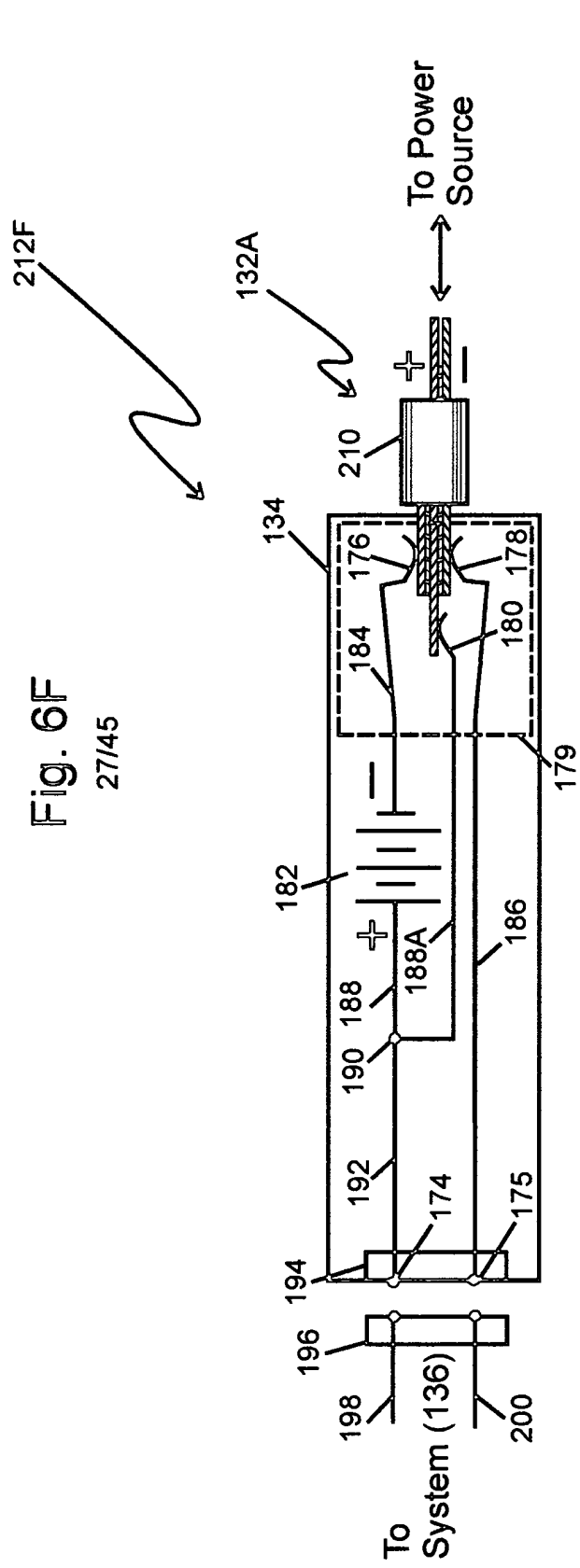


Fig. 7

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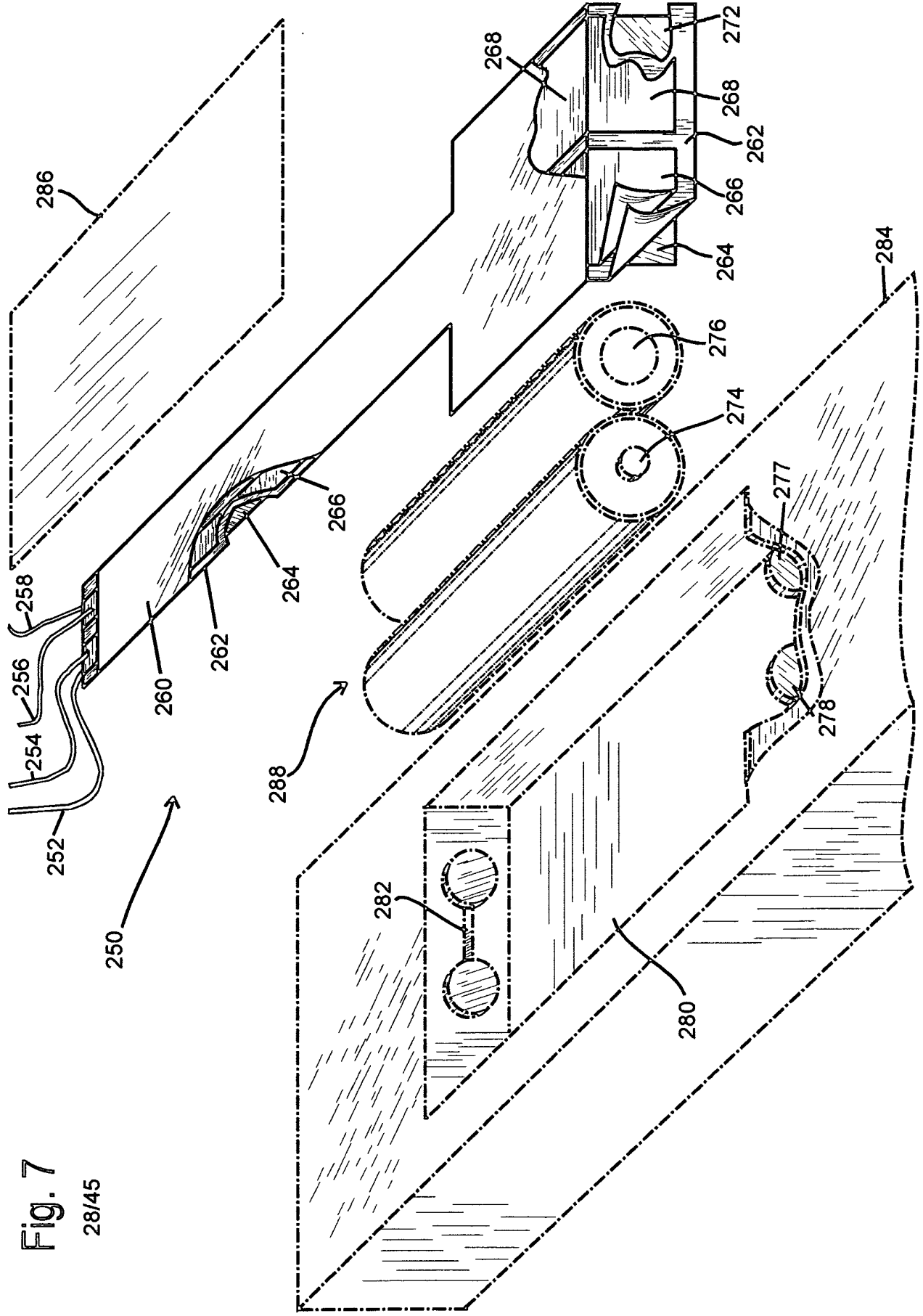


FIG. 8

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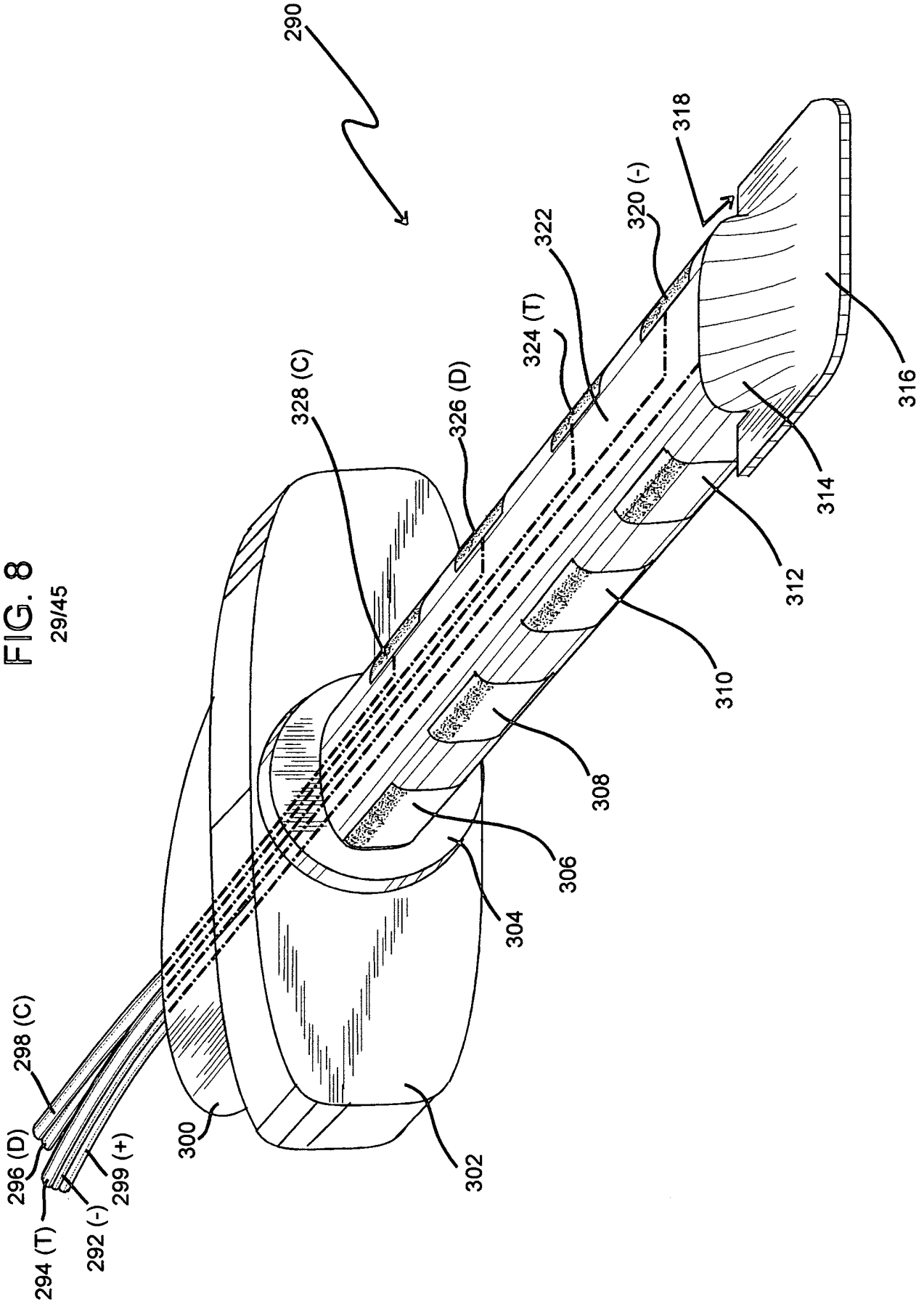


Fig. 9A

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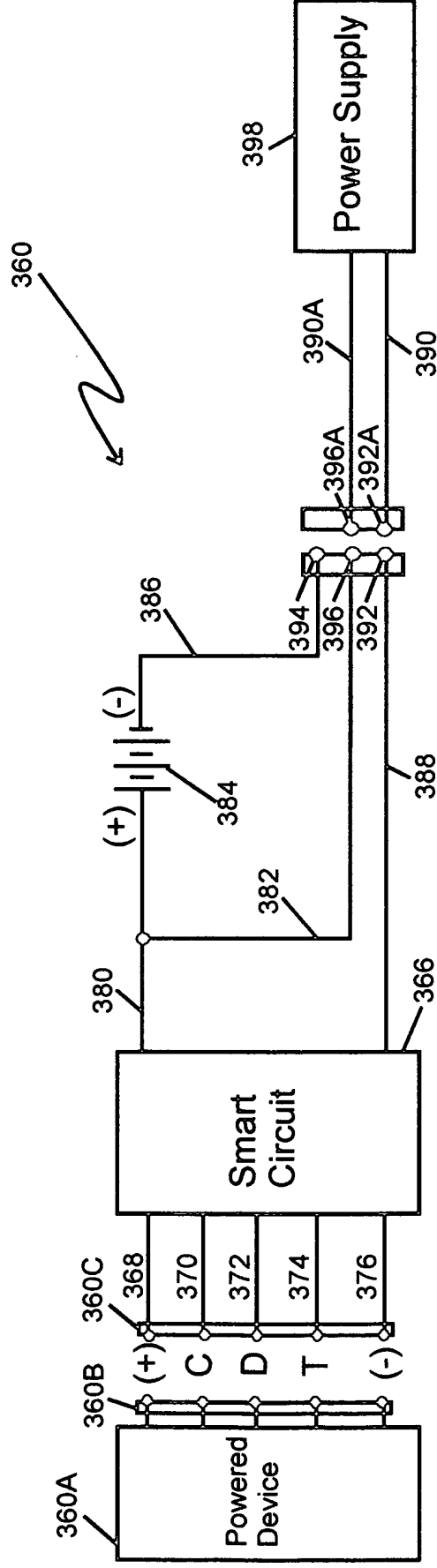


Fig. 9B

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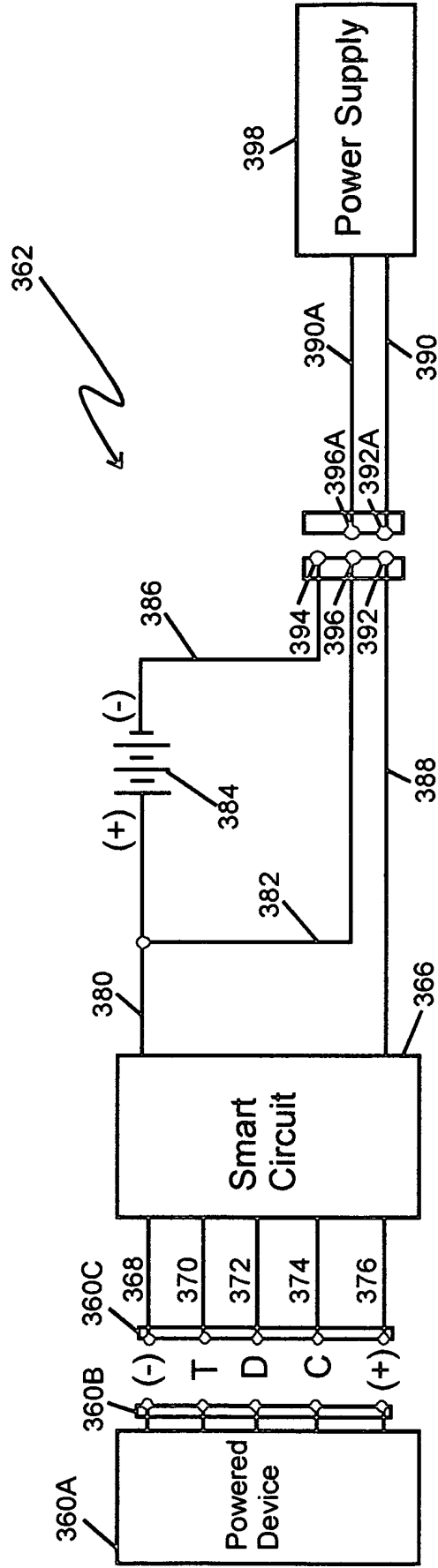


Fig. 9C

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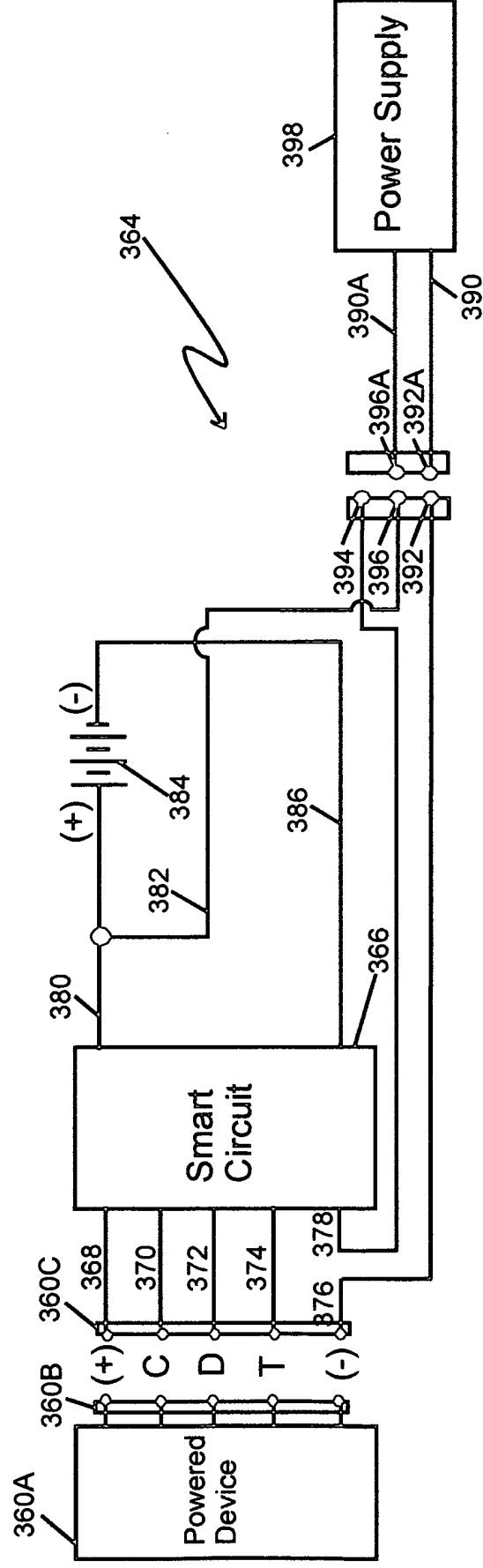




Fig. 9D

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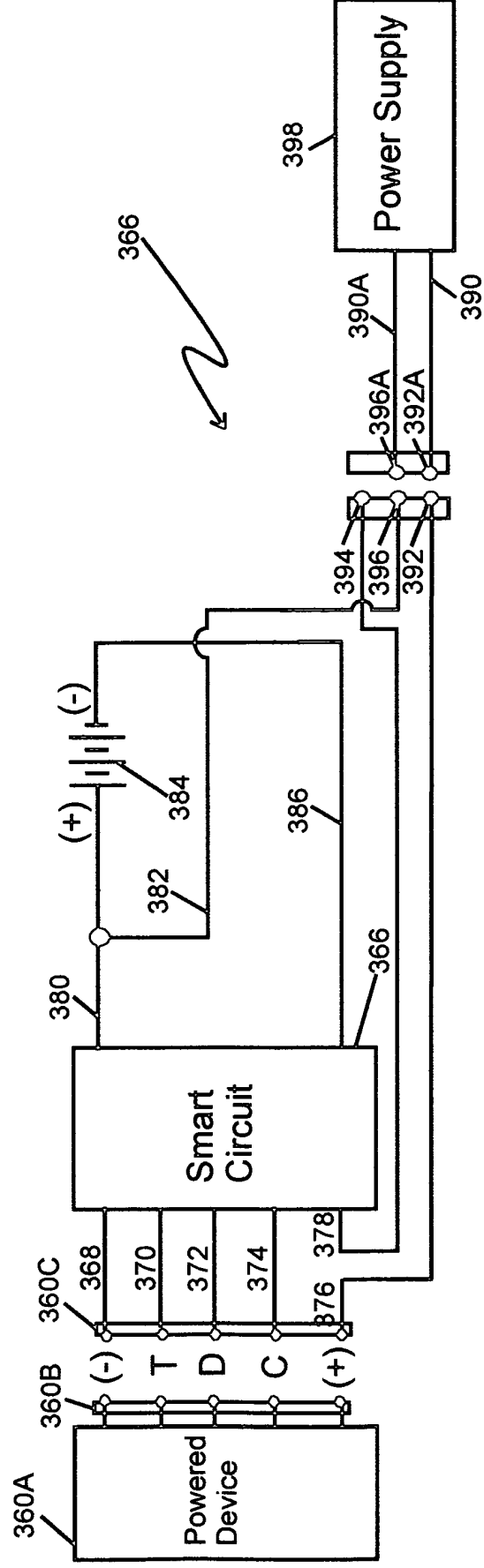


FIG. 10

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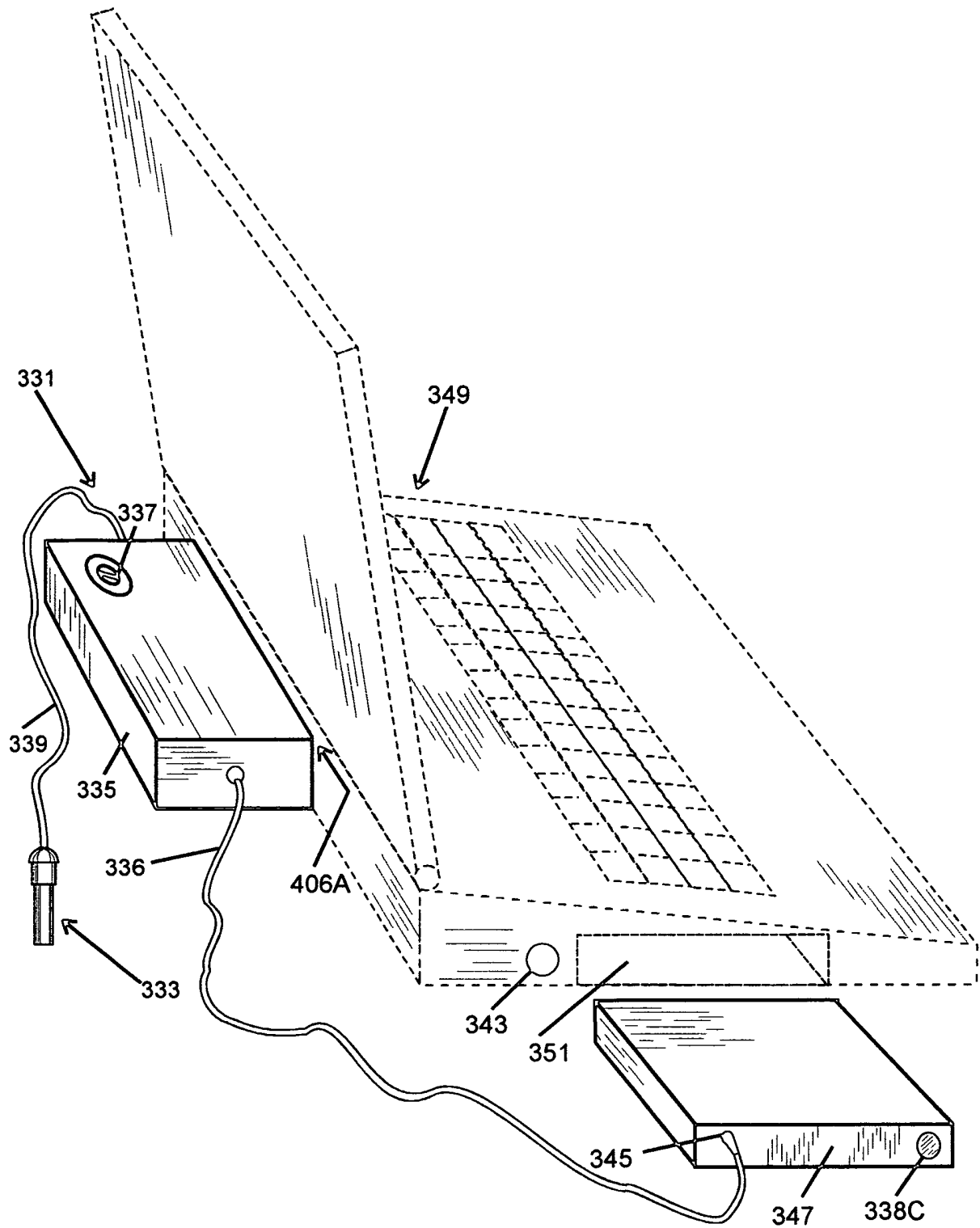


FIG. 11

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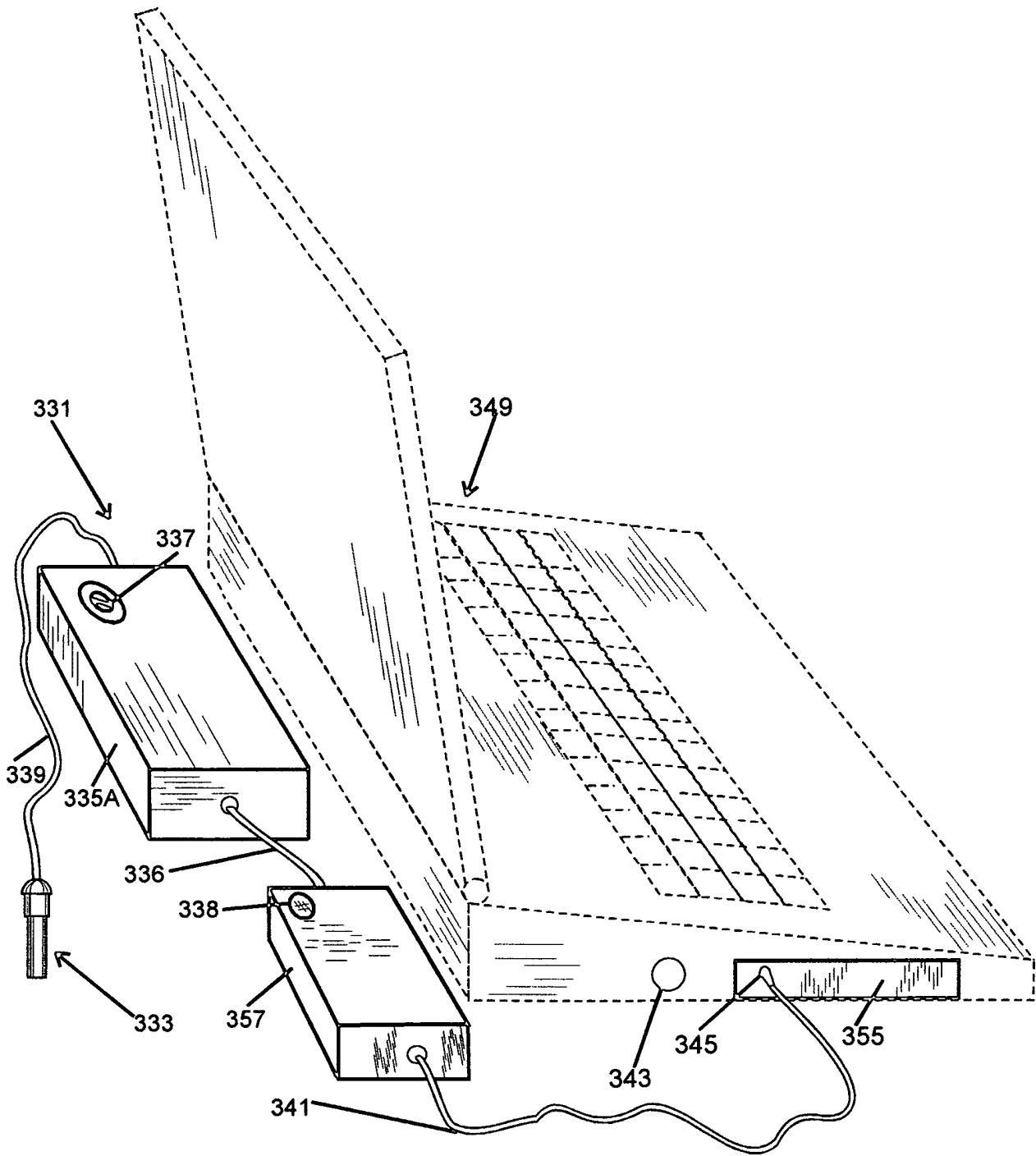


FIG. 12

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## Software Principles of Operation

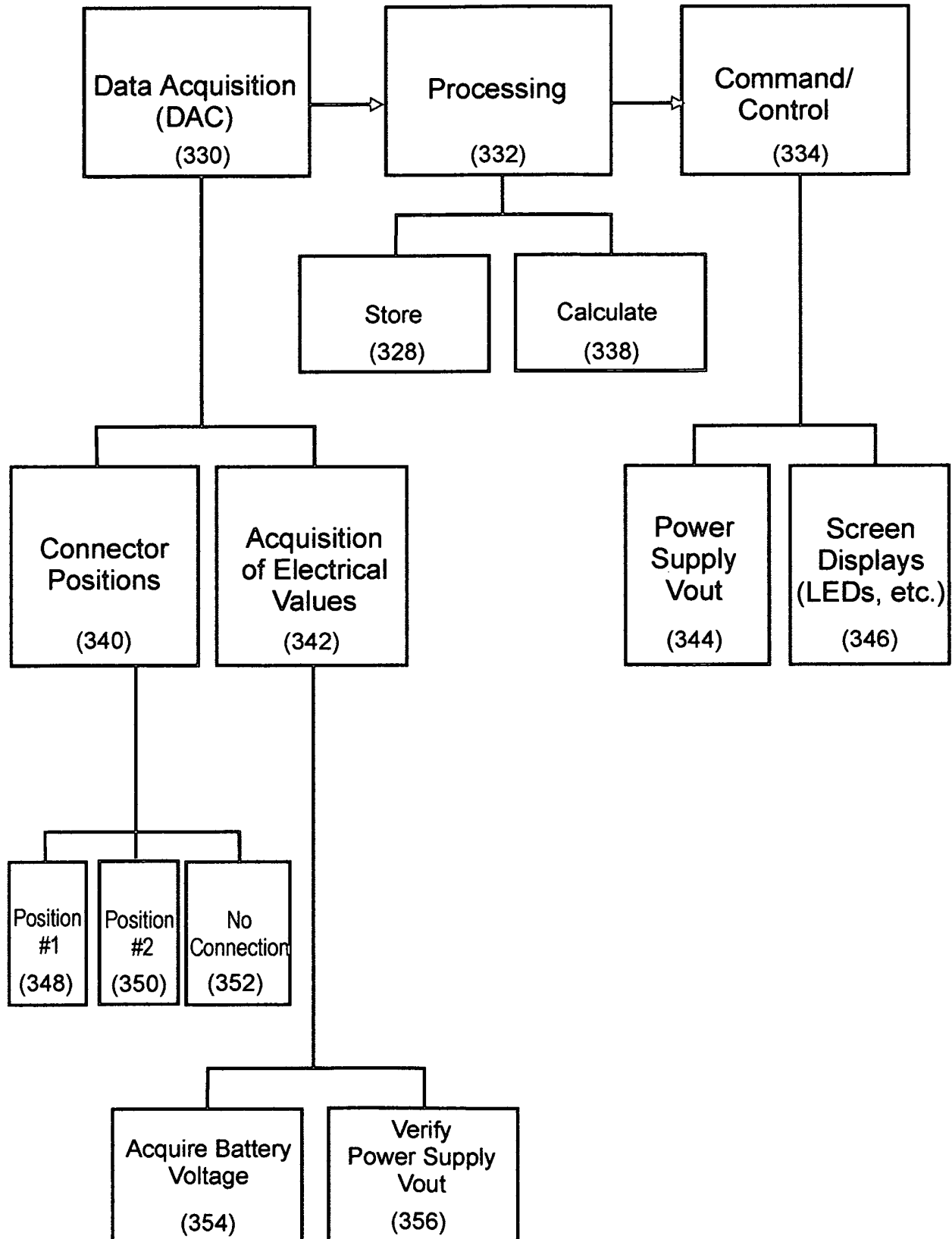
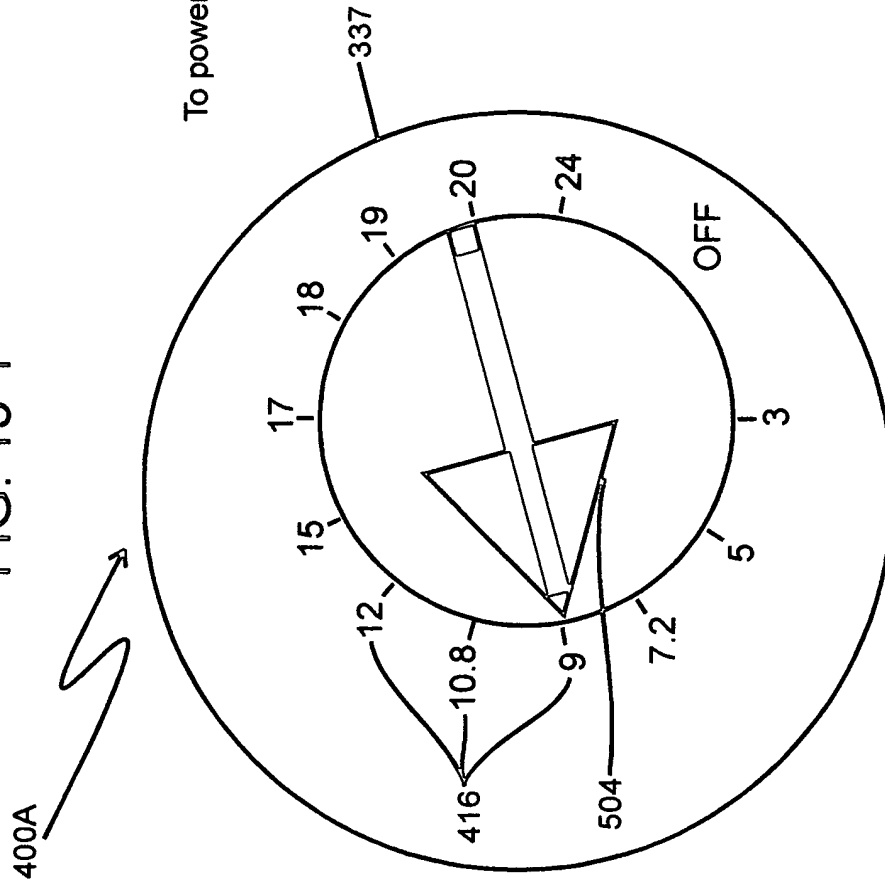


FIG. 13-1



**FIG. 13**  
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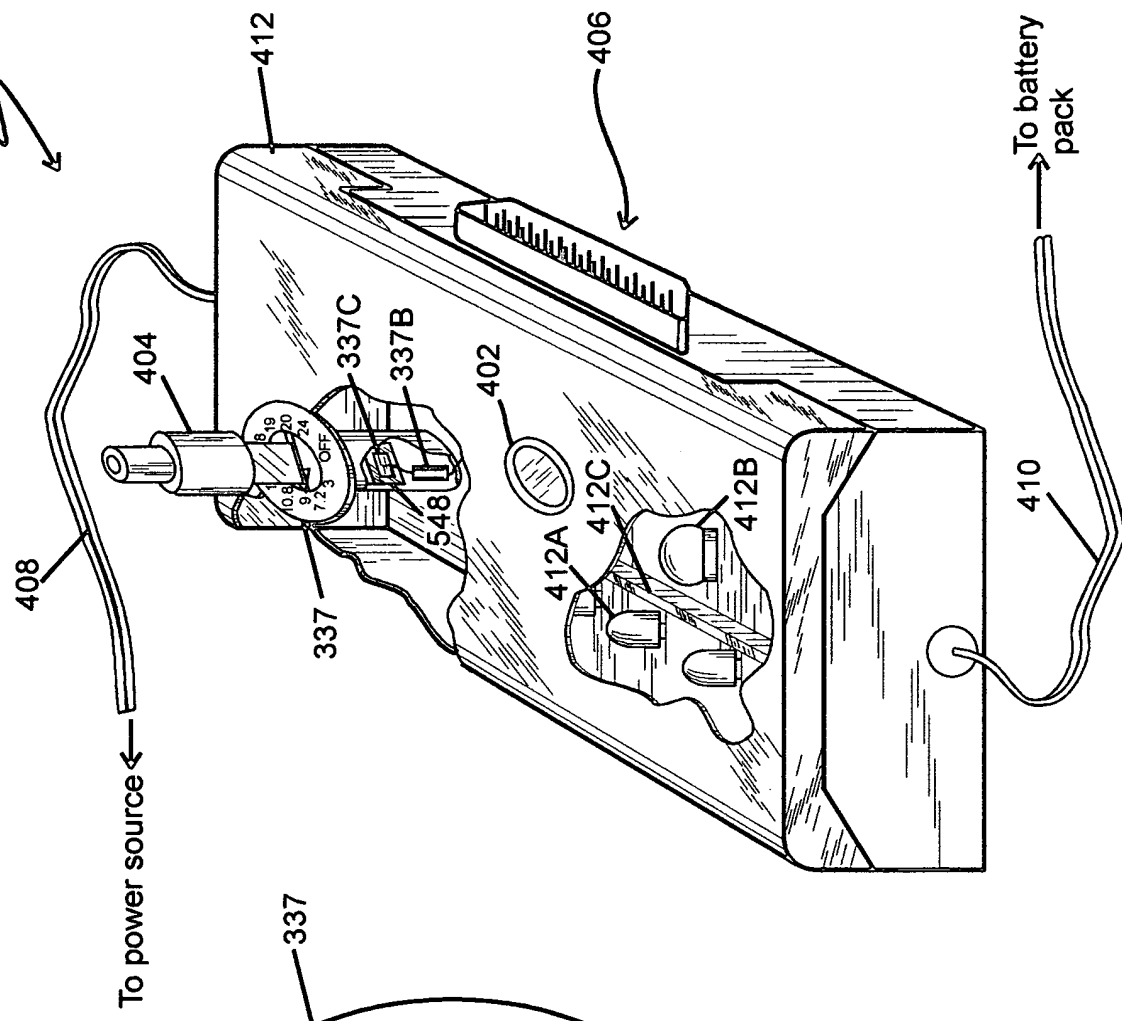
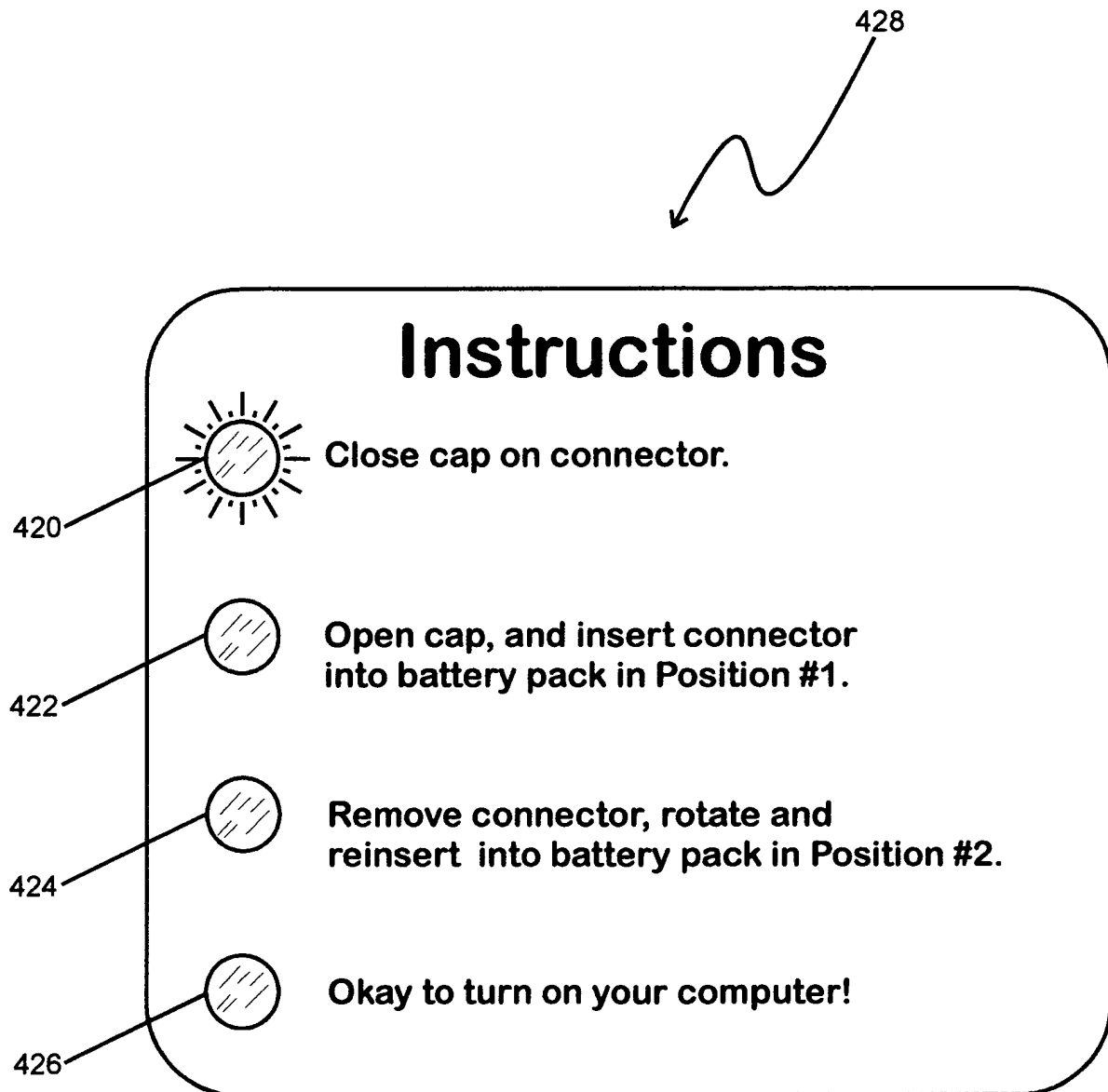




Fig 14

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**Fig. 15**  
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V<sub>min</sub> and V<sub>max</sub> Compared to Standard Battery Pack Voltages

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Voltages Are Shown As Design Minimum/Maximum Values					
	Ni-Cad	NiMH	Li-Ion (Coke)	Li-Ion (Graphite)	Li-Polymer
Cell Voltage	1.25/1.299	1.25/1.32	2.50/4.20	3.60/4.10 <sup>1</sup>	3.0/4.20
Cells/Pack <sup>2</sup>					
3	----	----	7.50/12.60	10.80/12.30	9.0/12.60
4	5.00/5.196	5.00/ 5.28	10.00/16.80	14.4/16.4	12.0/16.80
6	7.5/7.794	7.5/7.92	7.50/12.60	10.8/12.3	9.0/12.60
8	10.0/10.392	10.0/10.56	10.00/16.80	14.4/16.4	12.0/16.80
10	12.5/12.99	12.5/13.2	----	----	----
12	15.00/15.588	15.00/15.840	----	----	----
Minimum Cell Voltage <sup>3</sup>					
4	4.00	4.00	10.00	10.00	10.00
6	6.00	6.00	7.50	7.50	7.50
8	8.00	8.00	10.00	10.00	10.00
10	10.00	10.00	----	----	----
12	12.00	12.00	----	----	----
Load Current <sup>4</sup>	>1C	0.5C	1C	1C	1C

<sup>1</sup> Graphite-based Li-Ion cells are rated @ 3.0-4.1 VDC. Coke-based Li-Ion cells are rated @ 2.5-4.2 VDC.

<sup>2</sup> Voltage and cells-per-pack do not take into consideration whether cells in a pack are series or parallel wired. For example, a 14.4-volt Li-Ion pack can have two cell wiring configurations. Four-cell packs yield a 14.4 VDC pack rated @ 2025 MAh, while 8-cell packs are rated @ 14.4 VDC 4050 MAh.

<sup>3</sup> "Minimum Cell Voltage" is the lowest voltage to which a cell can safely be discharged.

<sup>4</sup> Load current is typically expressed as a ratio of charge rate.



Fig. 16

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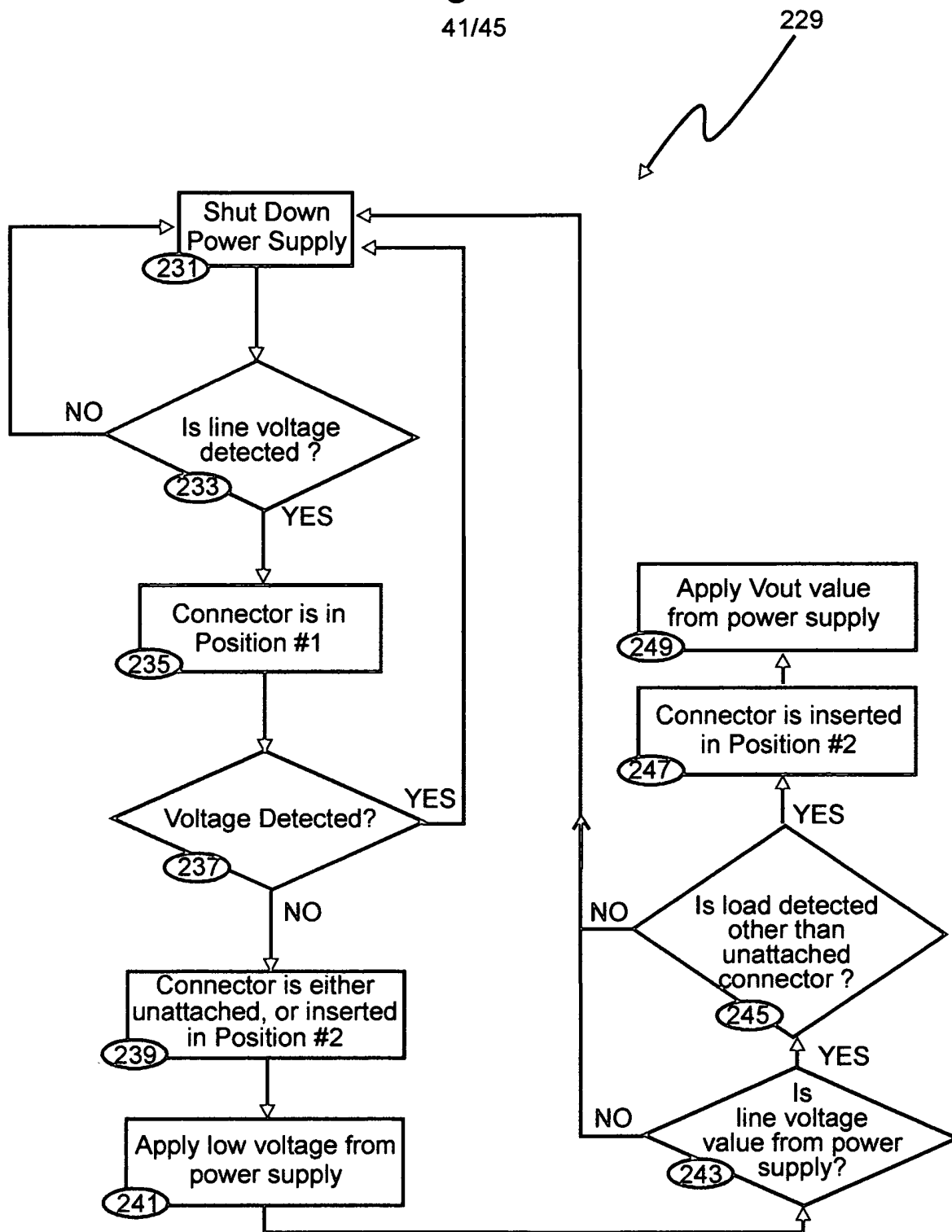


Fig. 17

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Connector Position	Software/Hardware Sensing Function
Not Connected	Sense voltage first. If no voltage detected, apply low power and sense current. <sup>1</sup>
Position #1 (To Battery Cells)	Sense voltage. <sup>2</sup>
Position #2 (To Powered Device)	Sense voltage first. If no voltage detected, apply low power and sense current. <sup>3</sup>

<sup>1</sup> If connector cover 530 in Fig. 6D is used, the resistive value of element 534 is predetermined and available in a software look-up table.

<sup>2</sup> Voltage detected will be from the battery, and not the power supply.

<sup>3</sup> Detected current will not be the same as that in footnote #1.

Fig. 18

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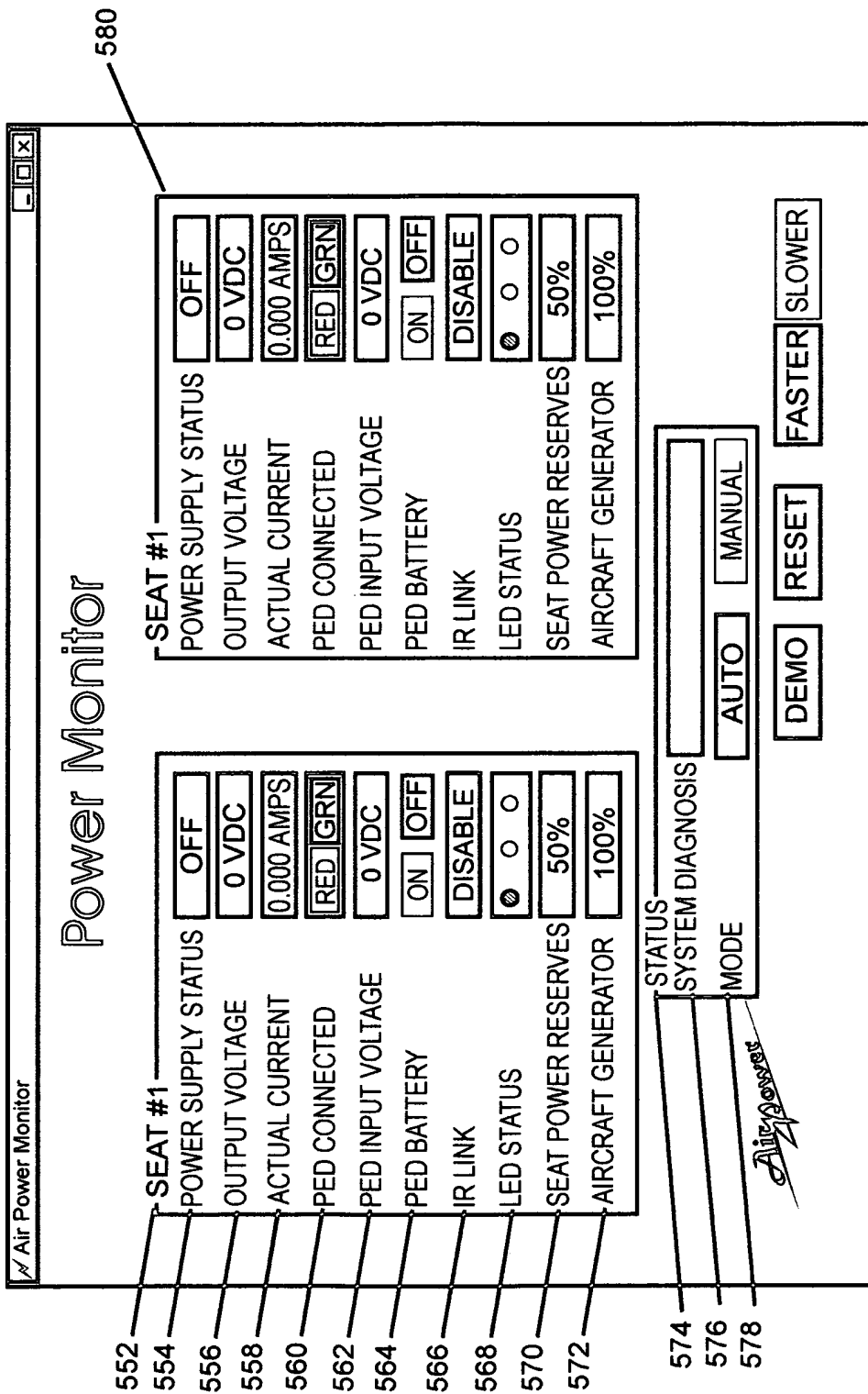
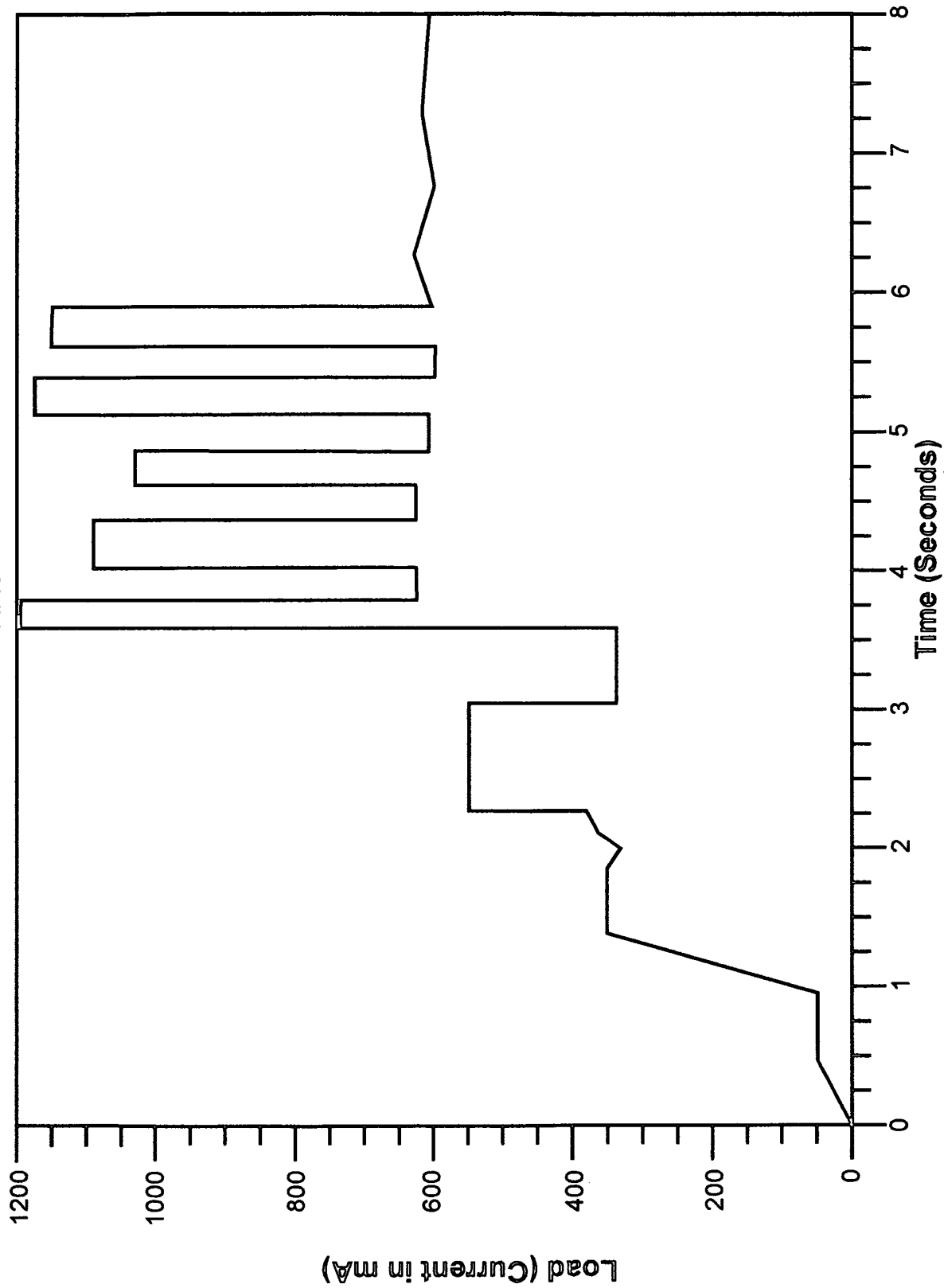


Fig. 19

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**Fig. 20**  
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Look-up Table: Line Load (Resistive Values)		
Line Load ( $\Omega$ Value) <sup>1</sup>	Identifier	Hardware Description
.20 Ohms	LL <sup>0</sup>	No power cord (power receptacle empty)
.45 Ohms	LL <sup>1</sup>	Power cord only (no connector attached)
.85 Ohms	LL <sup>2</sup>	Power cord, with connector attached (connector cap is attached)
.60 Ohms	LL <sup>3</sup>	Power cord, with connector attached (connector cap removed). Assembly is not inserted in battery pack.
LL <sup>4</sup> = LL <sup>3</sup> + Variable <sup>2</sup>	LL <sup>4</sup>	Power cord, with connector attached (connector cap removed). Assembly inserted in battery pack, but with GREEN Side #2 upward (correct insertion, but battery pack removed).
LL <sup>5</sup> = LL <sup>3</sup> + Variable <sup>3</sup>	LL <sup>5</sup>	Power cord, with connector attached (connector cap removed). Assembly inserted in battery pack, but with GREEN Side #2 upward (correct insertion, battery pack inserted in powered device). Powered Device is OFF.
LL <sup>5</sup> @ Vout	LL <sup>6</sup>	Computed value of LL <sup>5</sup> @ Vout. Basis is LL <sup>5</sup> @ low voltage.
LL <sup>7</sup> = LL <sup>6</sup> + Variable <sup>4</sup>	LL <sup>7</sup>	Power cord, connector assembly inserted #2, with powered device's switch turned on (computed @ Vout).

Allowable error = 5%

<sup>1</sup> The Ohm values shown are not necessarily indicative of actual resistance readings of actual devices. Since resistive values of any element can be manipulated at the time of manufacture, it would be prudent to use resistors to rectify any deviation from a set target value.

<sup>2</sup> The added load of a removed battery pack cannot be determined as a real-time event, but can only be a pre-determined load, or range of loads.

<sup>3</sup> "Variable" is added load of powered device circuits between the battery pack and the ON/OFF switch.

<sup>4</sup> "Variable" is a detectable (and likely significant) increase in powerline load, as compared to known value LL<sup>6</sup>.